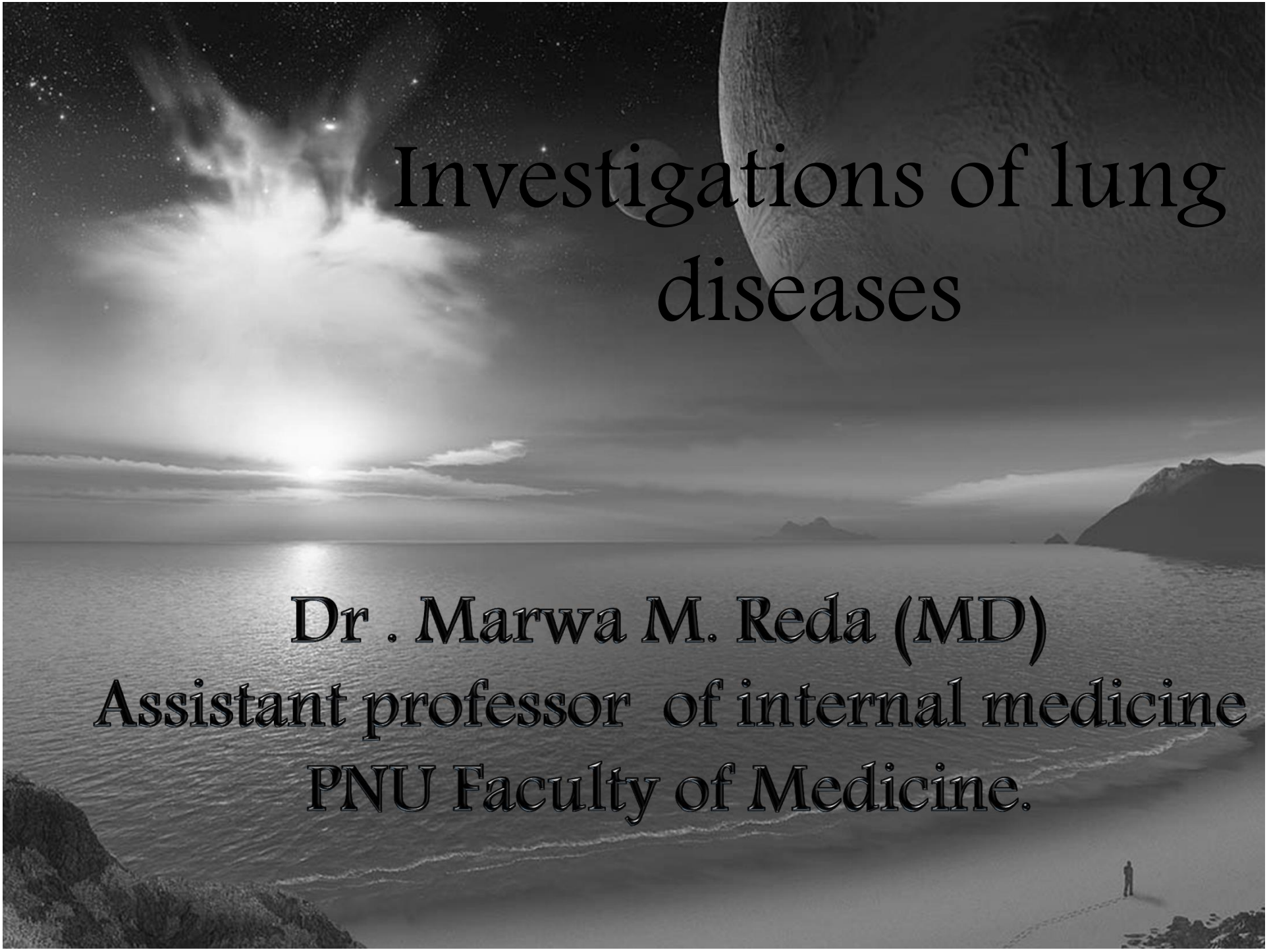

"قالوا سبحانك لا علم لنا إلا ما علمتنا"
البقرة 32
"و ما أُتيتم من العلم إلا قليلا"
الأسراء85


Investigations of lung diseases
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ILO'S

- **Diagnostic imagings.**
- **Laboratory investigations & evaluations of pulmonary function tests.**
- **Procedures in pulmonary medicine.**

Essentials of Diagnosis

- Goals of the history are to develop a probable diagnosis or limited differential diagnosis and to assess severity of illness.
- Important features of symptoms include severity, chronicity, moderating and aggravating factors, and associated systemic symptoms.
- Risk factors for lung disease are identified in past medical, family, social, occupational, environmental, and drug histories.
- Physical &Pulmonary examination should be directed to narrow the differential diagnosis or confirm a specific diagnosis.

DIAGNOSTIC RADIOGRAPHIC IMAGINGS

- Radiography plays a central role in the detection, diagnosis, and serial evaluation of thoracic disease.

- The radiographic methods include:

1. Conventional chest radiography
2. Ultrasonography.
3. Helical computed tomography (CT) and the development of multislice computed tomography (MSCT).
4. Magnetic resonance imaging (MRI).

Conventional Chest Radiography

Conventional chest radiography

- Conventional chest radiography plays a fundamental role in the diagnosis of chest disease.
- Chest radiography is almost always the initial imaging procedure performed when chest disease is suspected, and, despite the development of other imaging methods, chest radiography remains one of the most frequently performed radiographic examinations.

Indications for the use of chest radiography

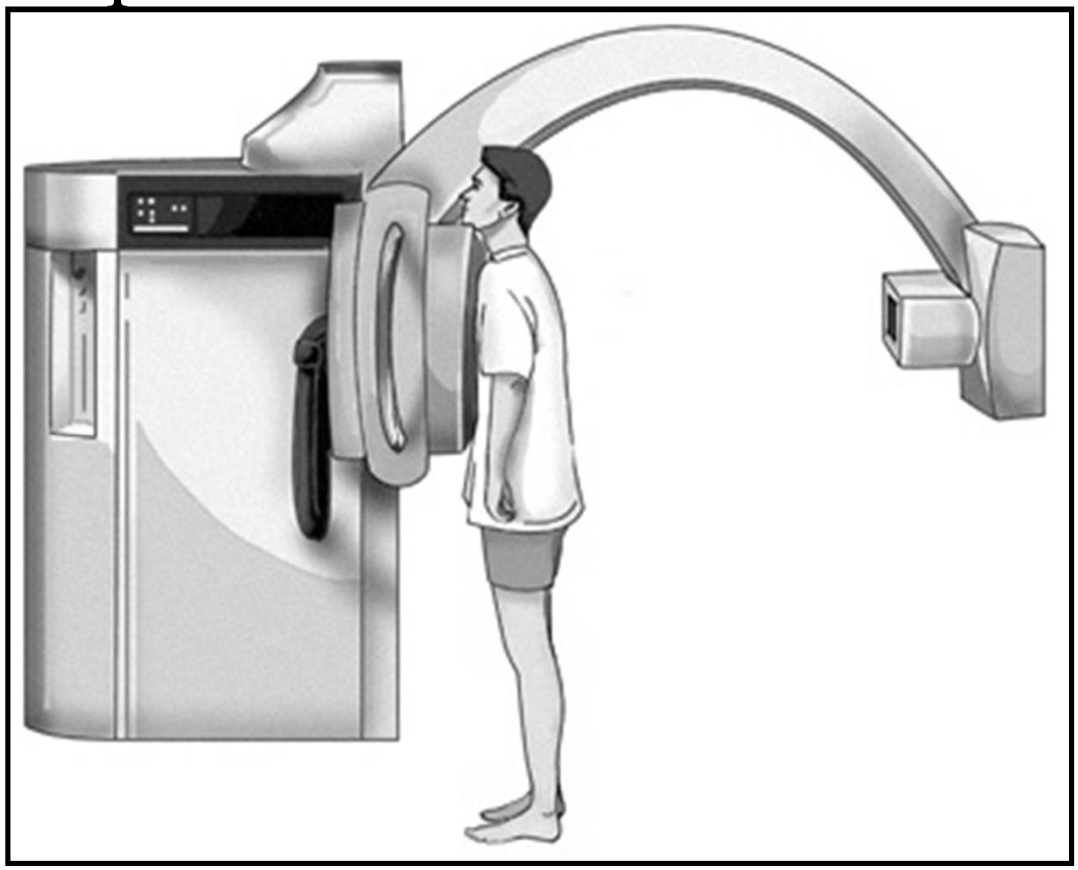
1. The assessment of both acute (e.g., Pneumonia) and chronic (e.g., Chronic obstructive pulmonary disease) lung diseases,
2. Assessment of dyspnea or other respiratory symptoms,
3. Evaluation of treatment success in patients with acute lung disease,
4. Follow-up of patients with a known chronic lung disease,
5. Monitoring of patients in intensive care units,

Indications for the use of chest radiography (cont.)

6. Diagnosis of pleural effusion,
7. Screening for asymptomatic diseases in patients at risk,
8. Monitoring patients with industrial exposure,
9. Preoperative evaluation of surgical patients,
10. The initial imaging study in patients with lung cancer and other tumors, vascular abnormalities, and hemoptysis.

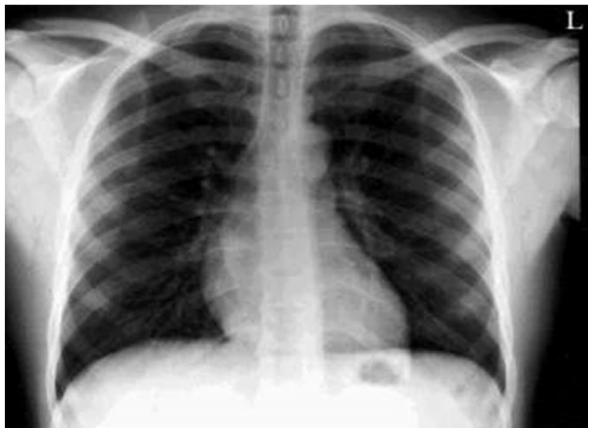
- A routine chest radiographic examination in an ambulatory patient usually consists of postero-anterior and left lateral projections.

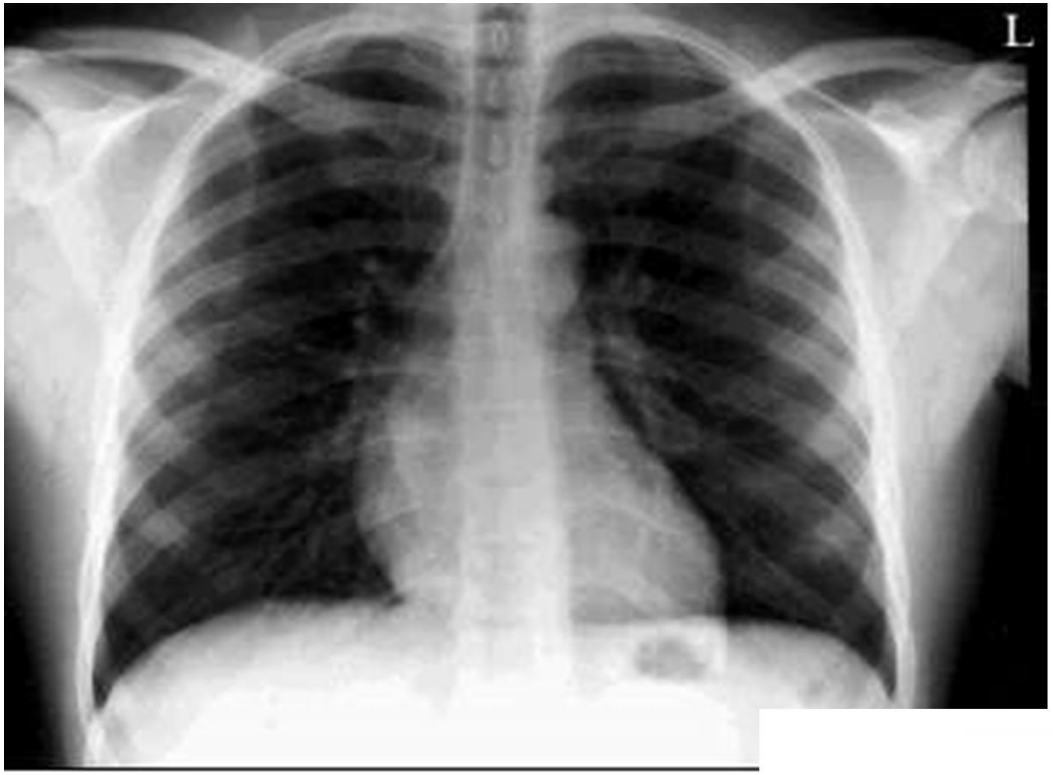
- The postero-anterior (PA): the X-ray beam going from the patient's back toward the anterior chest.



Normal chest x-ray

- Conventional radiographs are made at total lung capacity (i.e., full inspiration “10 posterior ribs should be visible and 6 anterior ribs), thereby permitting the greatest volume of lung to be evaluated for possible pathology and providing the most contrast between intrapulmonary air and normal and abnormal intrathoracic structures.

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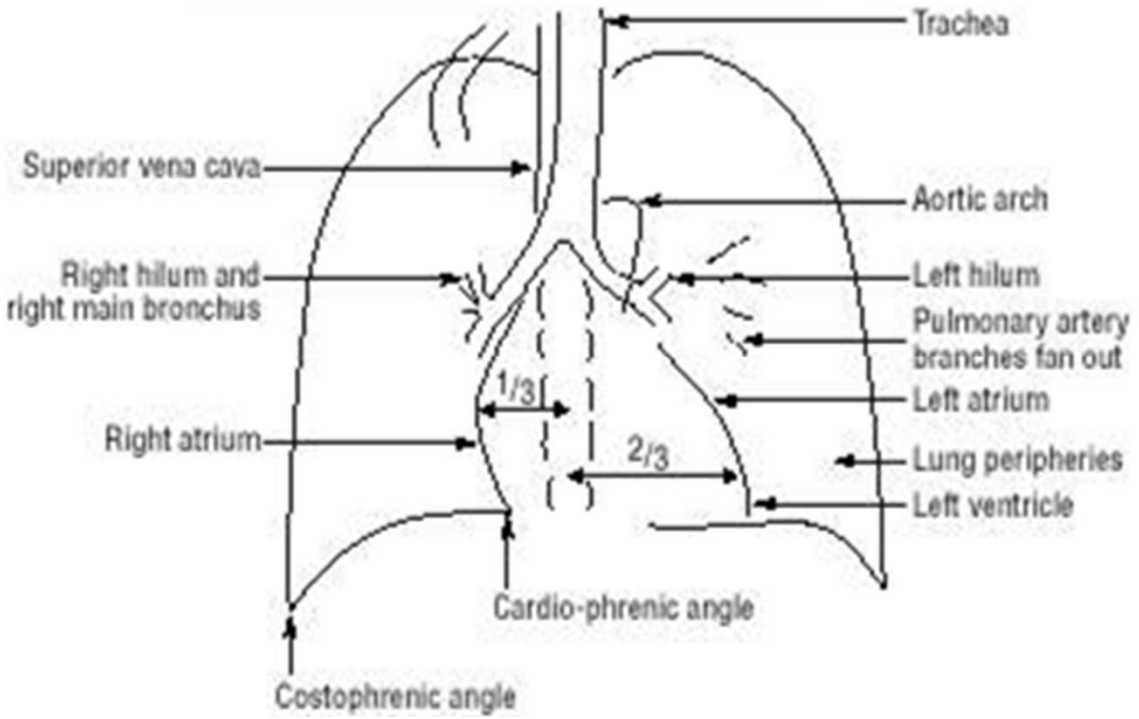
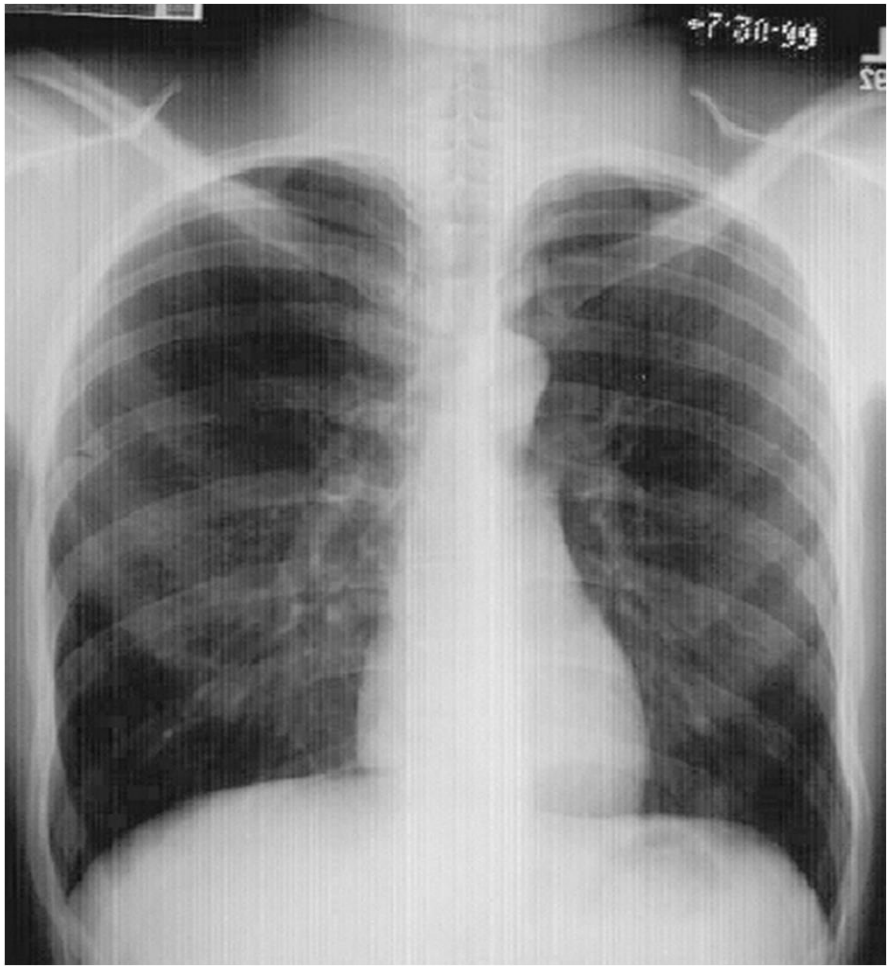
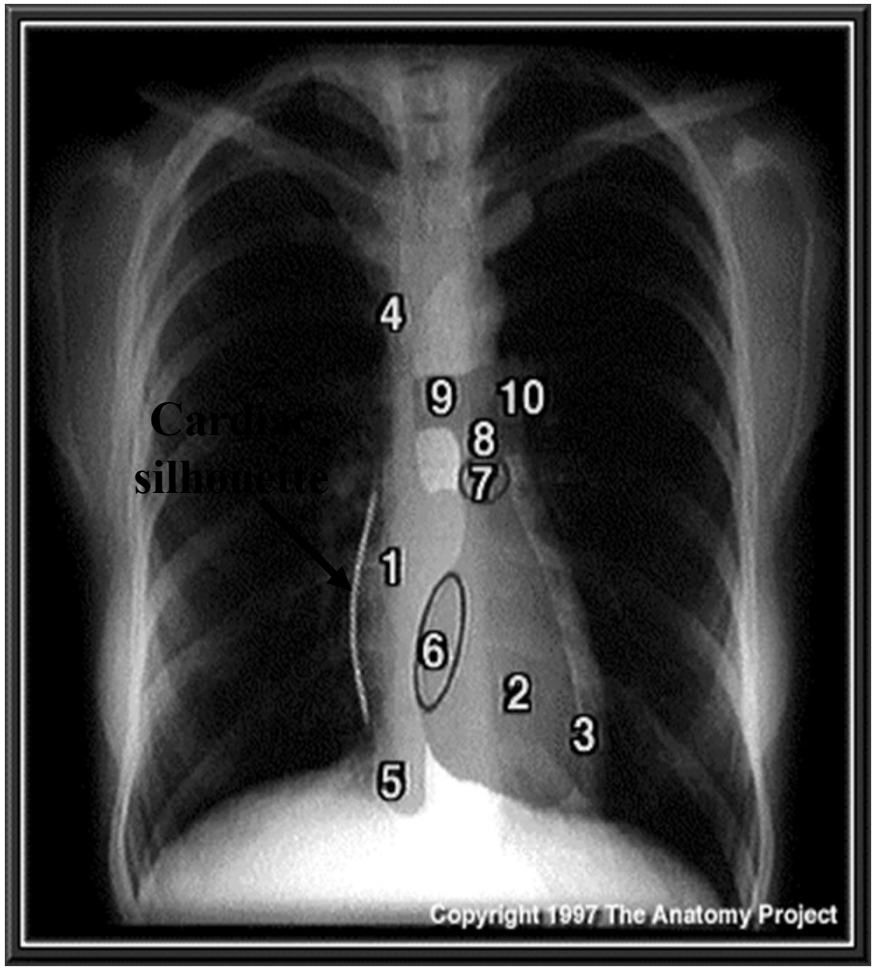

Trachea
Superior vena cava
Aortic arch
Right hilum and
right main bronchus
Left hilum
Pulmonary artery
branches fan out
1/3
Left atrium
Right atrium
2/3
Lung peripheries
Left ventricle
Cardio-phrenic angle
Costophrenic angle

Normal chest x-ray

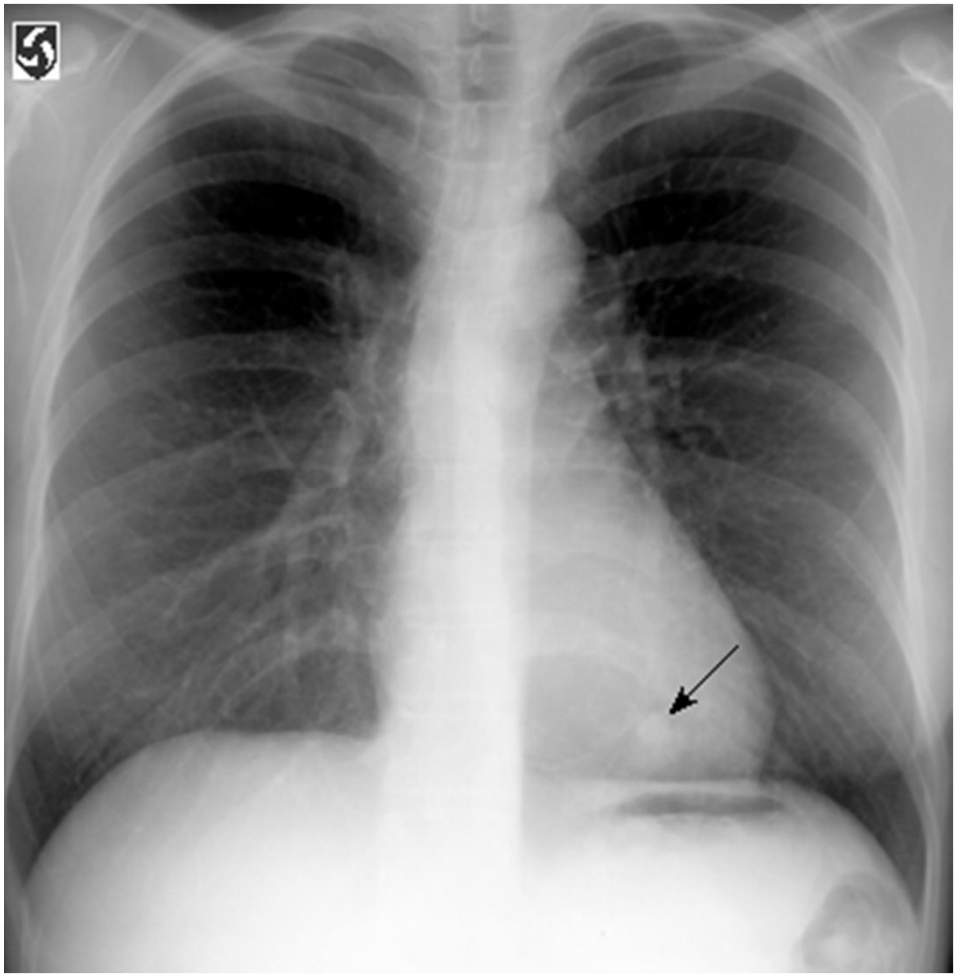


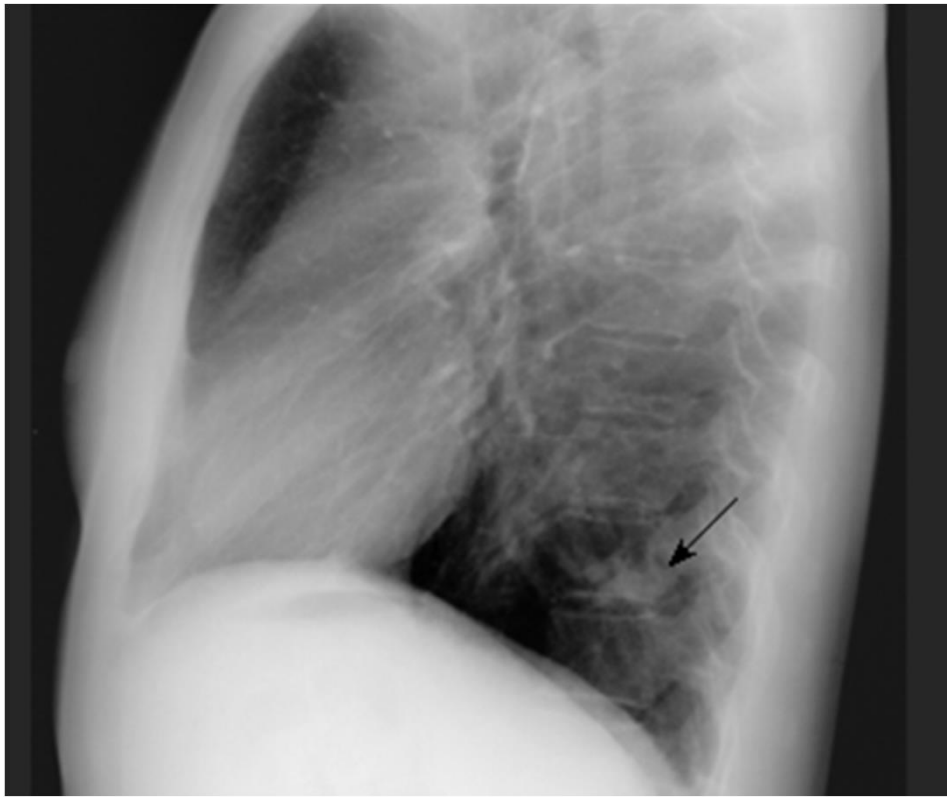


1. R Atrium
2. R Ventricle
3. Apex of L Ventricle
4. Superior Vena Cava
5. Inferior Vena Cava
6. Tricuspid Valve
7. Pulmonary Valve
8. Pulmonary Trunk
9. R PA 10. L PA

- The utility of routine lateral radiographs, however, has been questioned.
- Lateral radiograph should be obtained in patients with suspected chest disease and in screening examinations of patients 40 years of age or older.

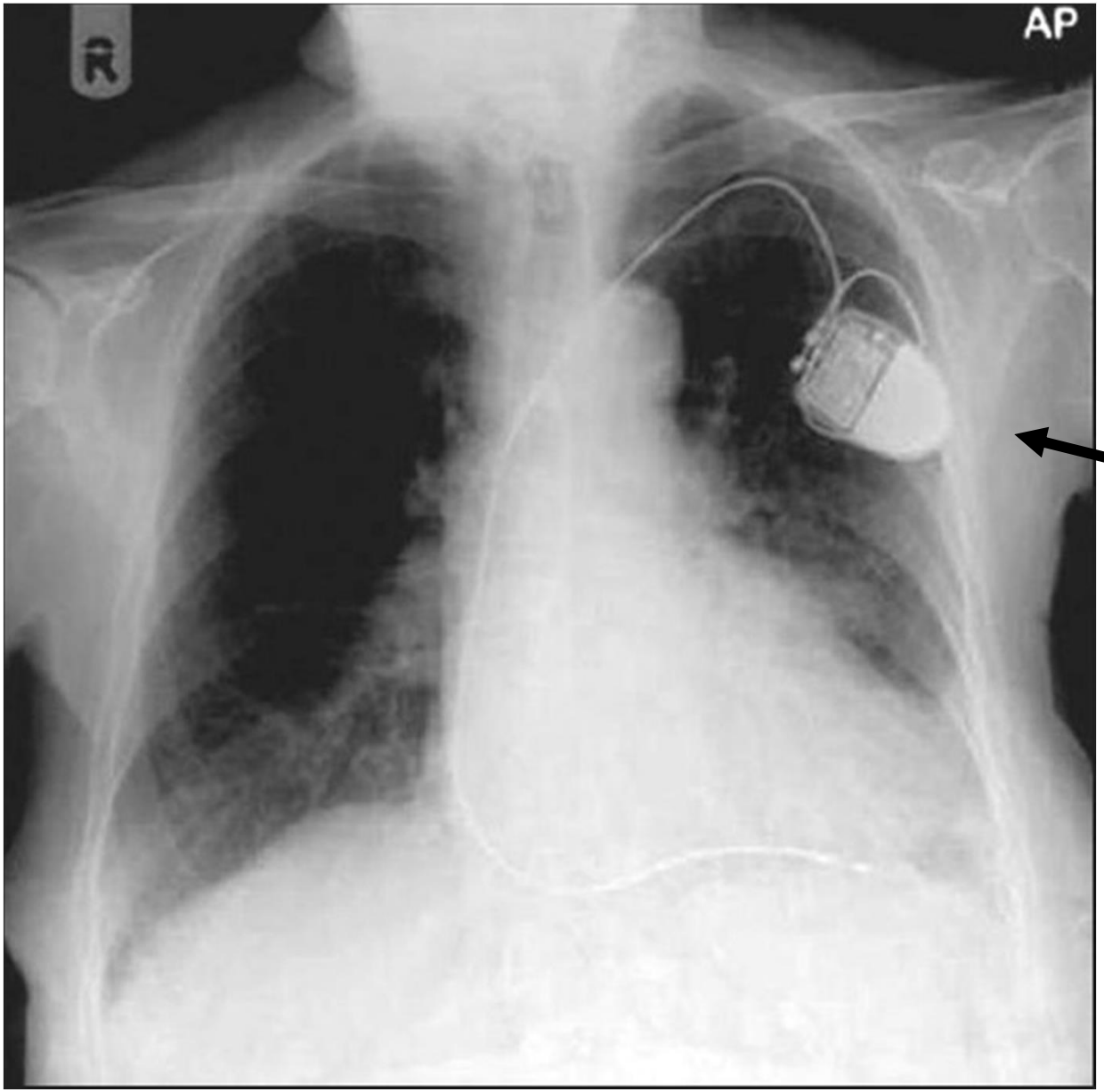
Lateral chest *x* ray (normal)





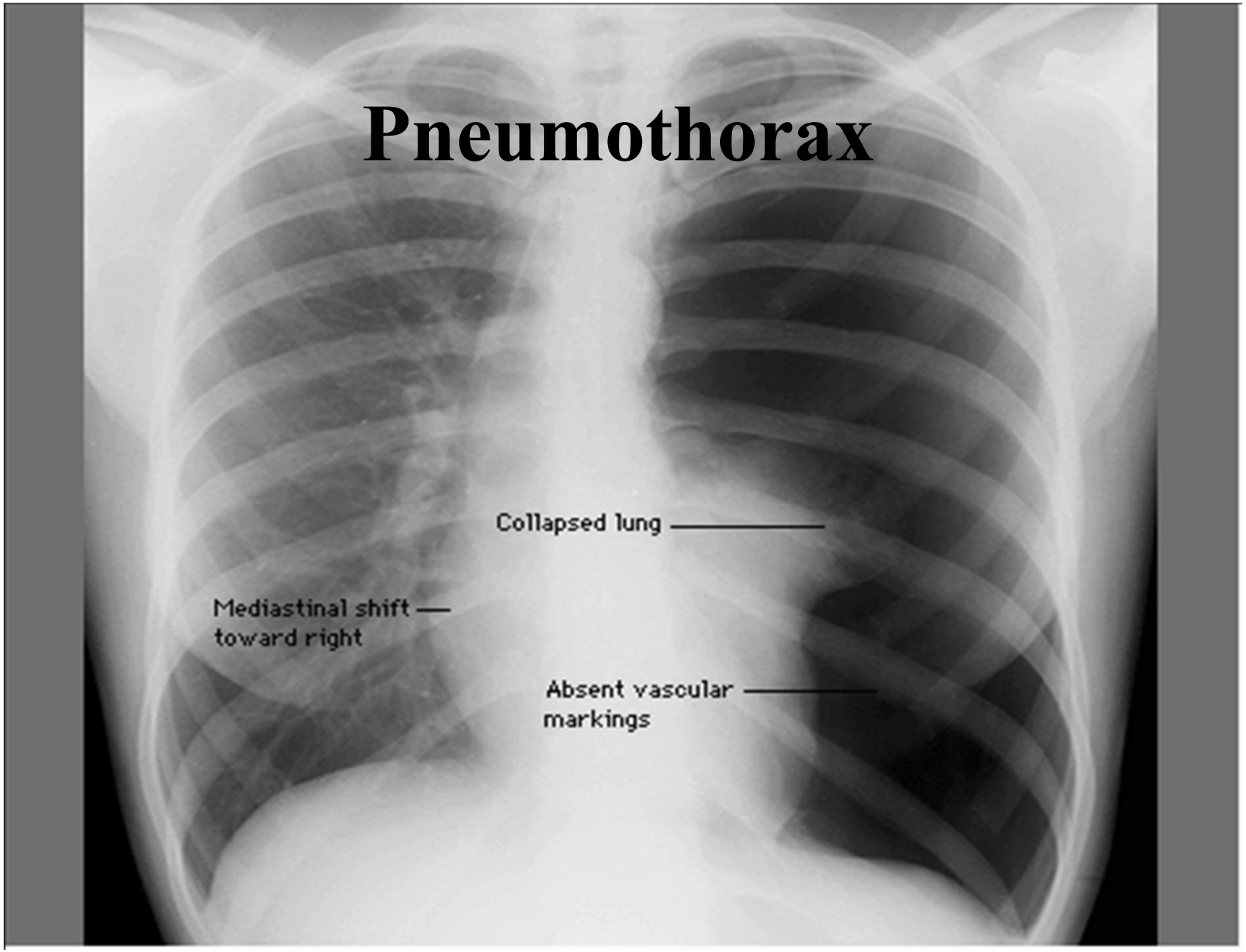
Color variations found on chest radiographs

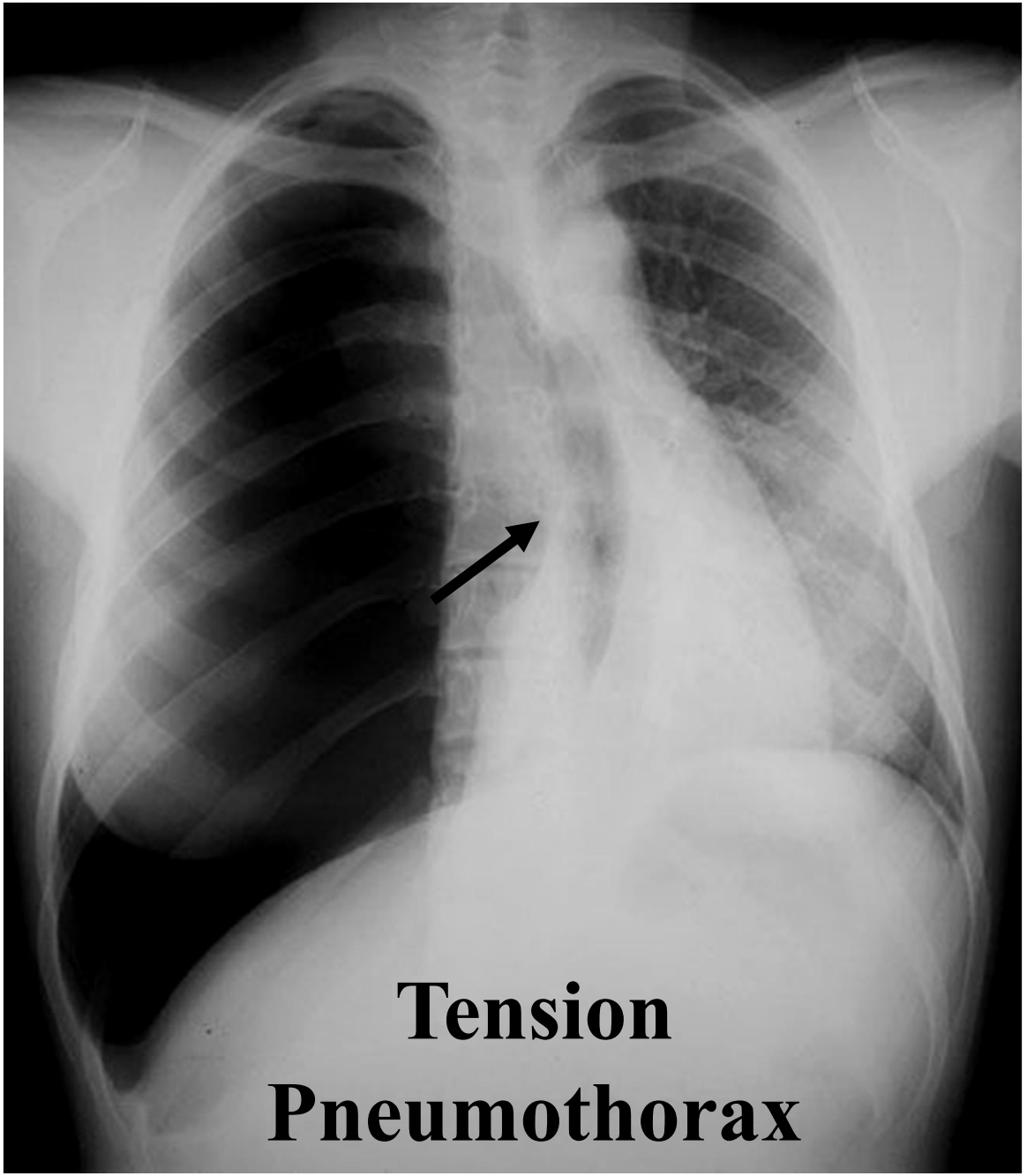
	Black	Dark Grey	Light Grey	Off-White	Bright White
Color Gradient					
Appearance and Examples	**Air** will appear black on a well exposed chest film. e.g. the trachea & Bronchus	**Tissues** appearing dark grey on the film e.g. subcutaneous tissue and fat	**Semi-solid organs** will appear light grey on the film. e.g. the heart & major blood vessels	**Organs** appearing off white e.g. Diaphragm, bones such as the clavicle and ribs	**Metals** such as jewelry, sternal wires, and metal implants

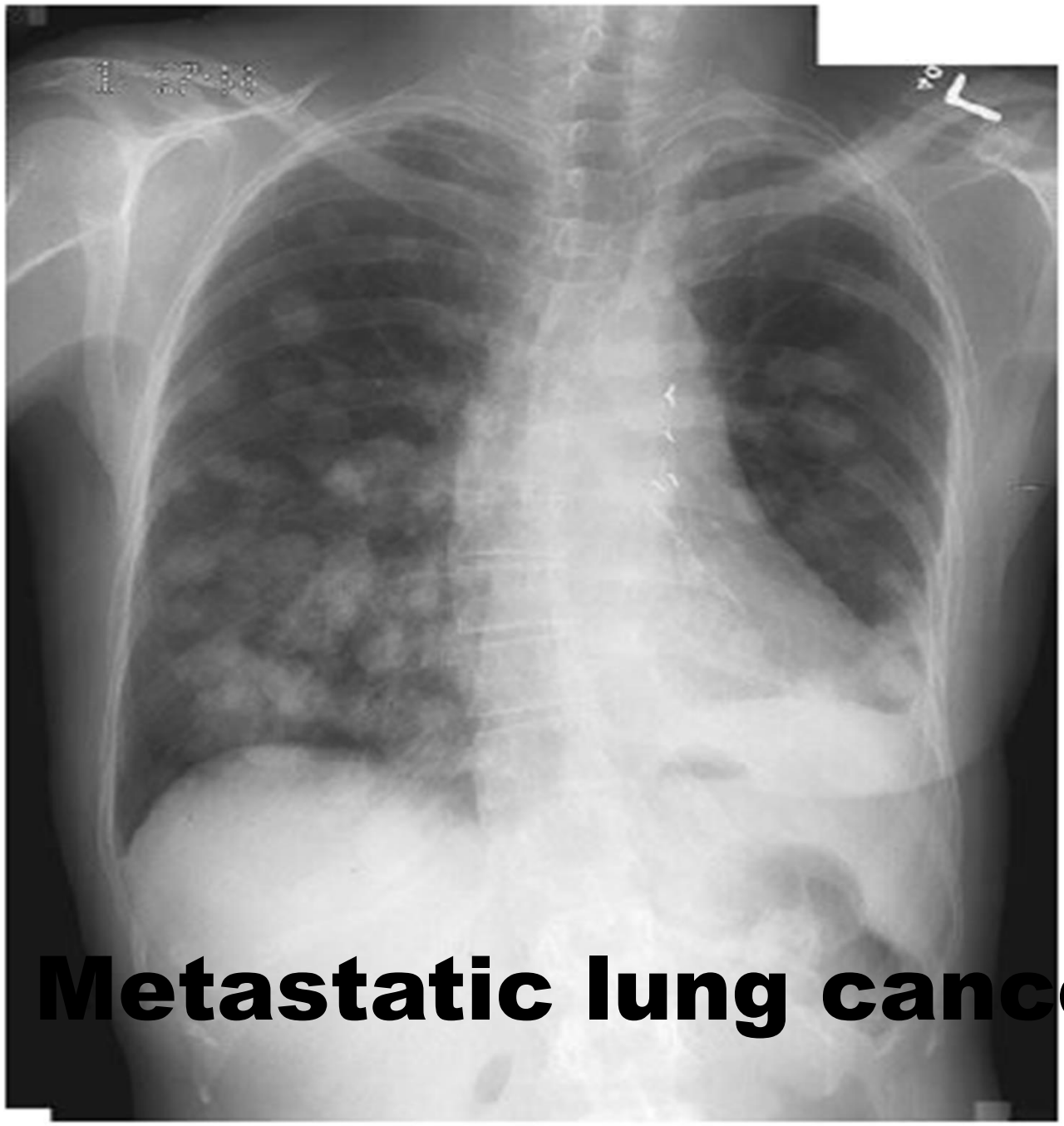


Cardiac pacemaker

Pneumothorax



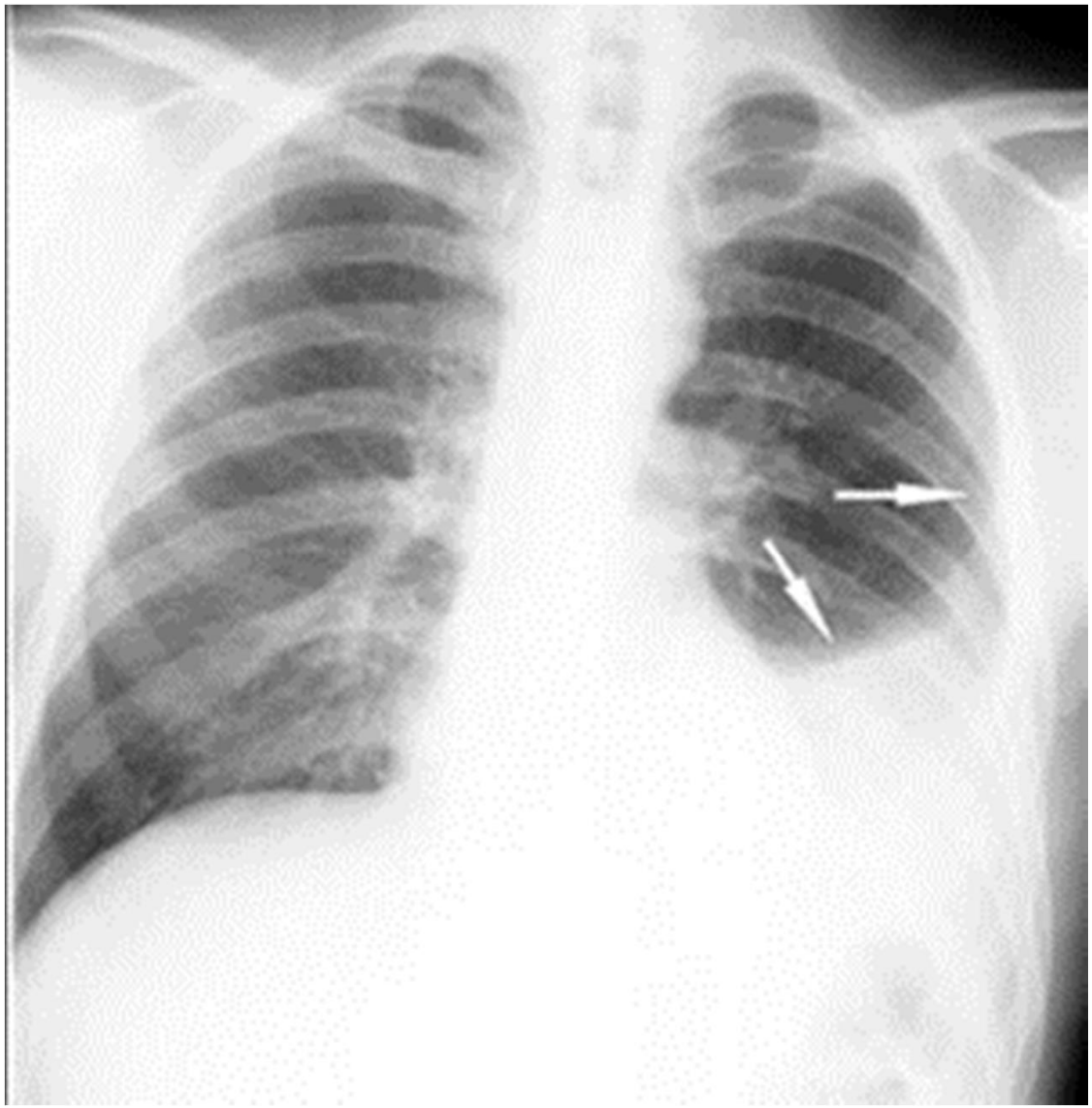

Tension
Pneumothorax



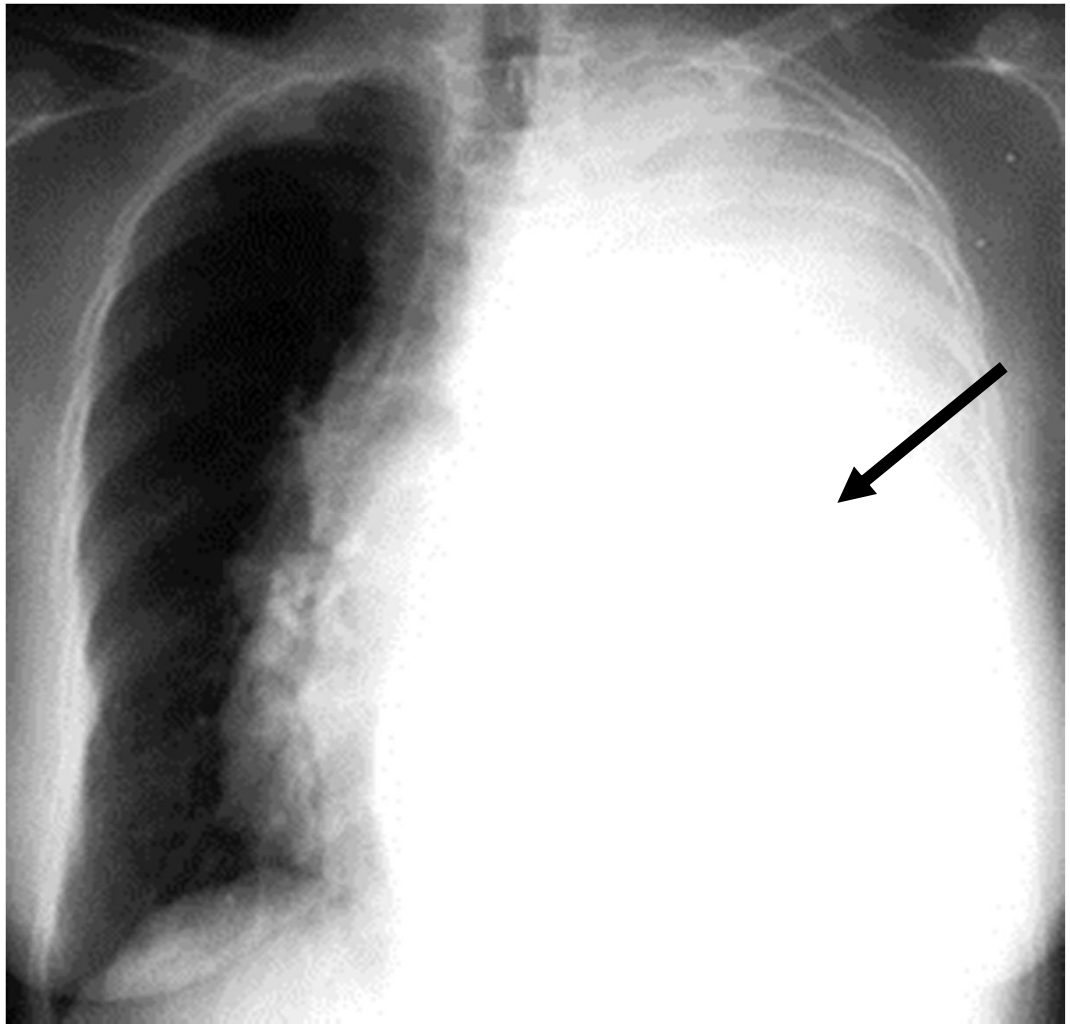
Metastatic lung cancer

COPD

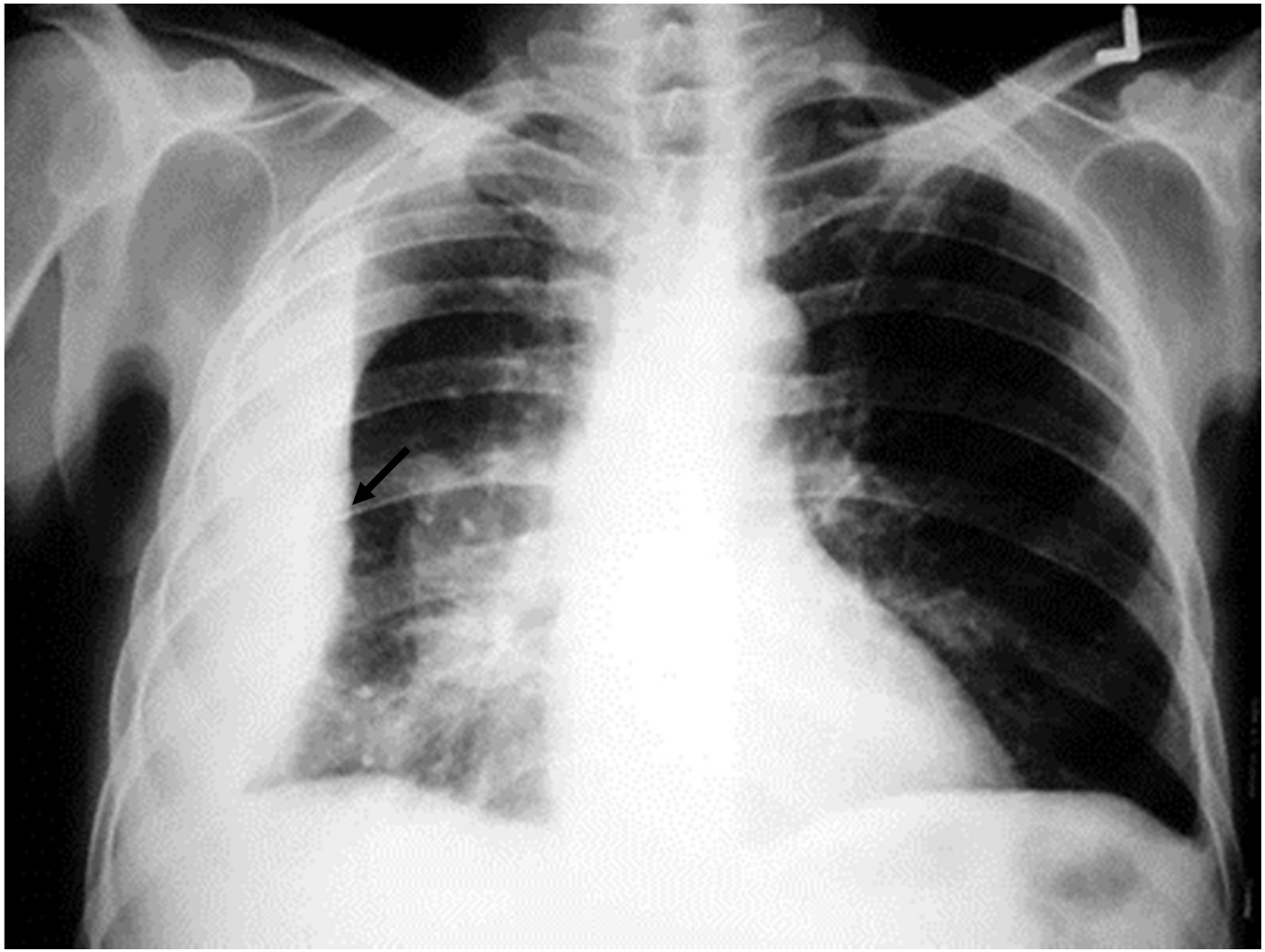
PA view; Lt pleural effusion (meniscus sign)

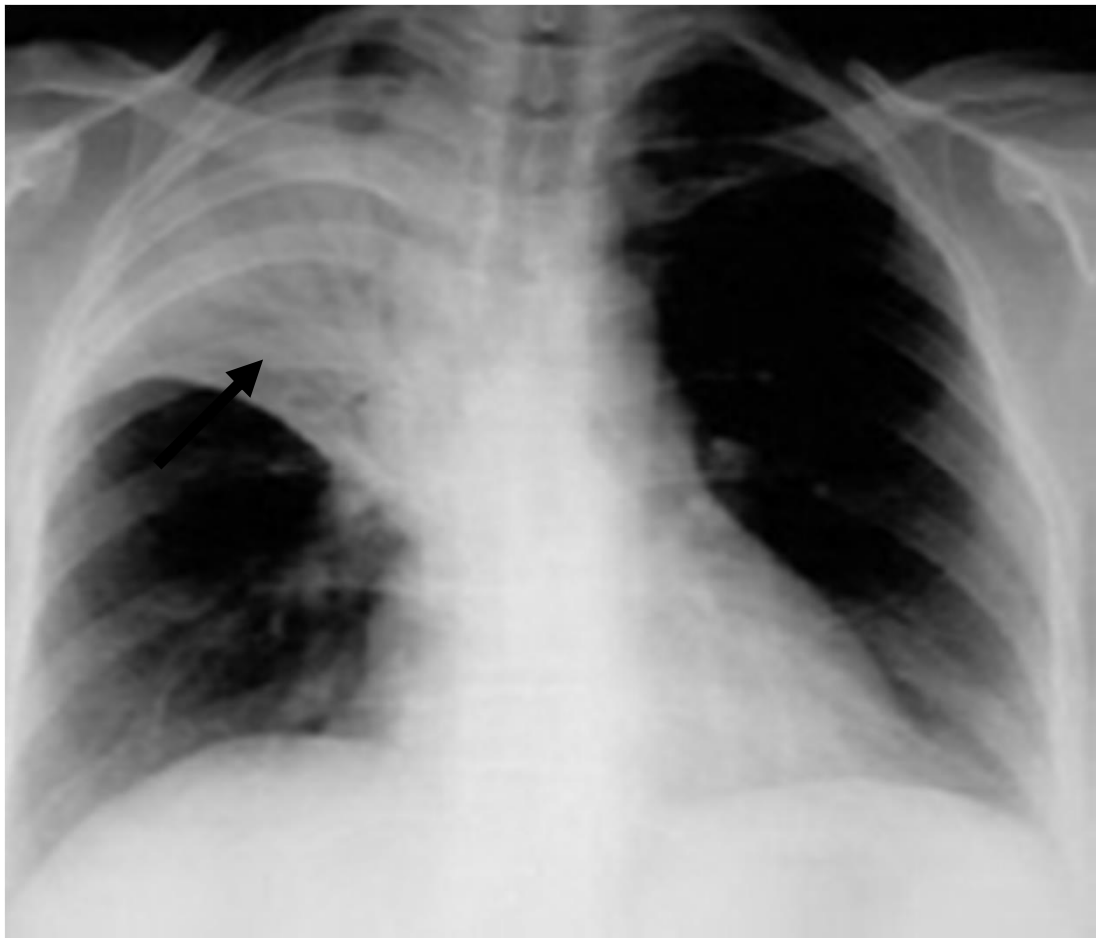


A massive left-sided pleural effusion with contralateral mediastinal shift

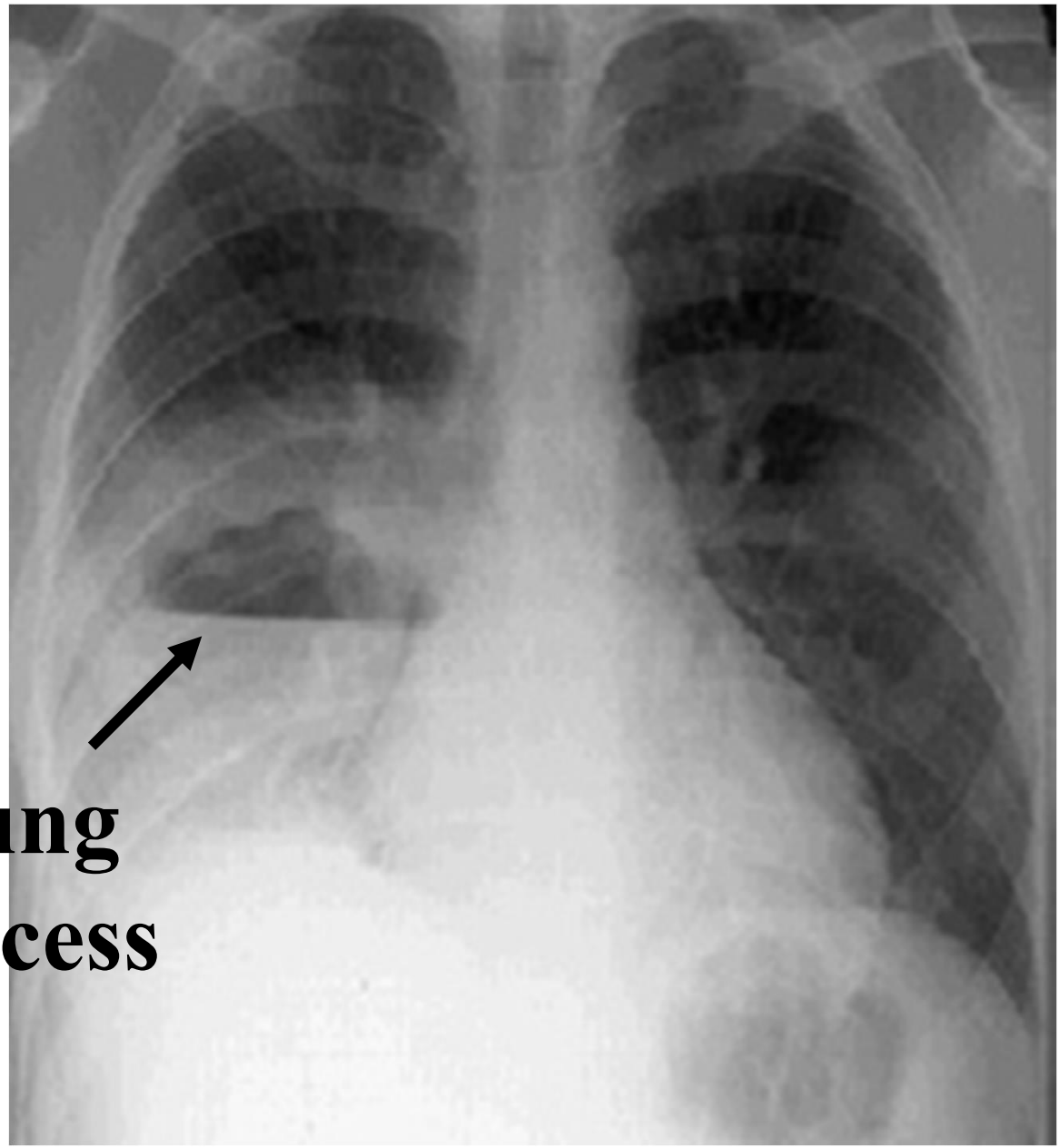


Rt Loculated pleural effusion





Right upper lobe lobar pneumonia secondary to Streptococcus pneumoniae infection


Lung
abscess

A lung mass abuts the mediastinal surface and creates acute angles with the lung .

A mediastinal mass will sit under the surface of the mediastinum, creating obtuse angles with the lung

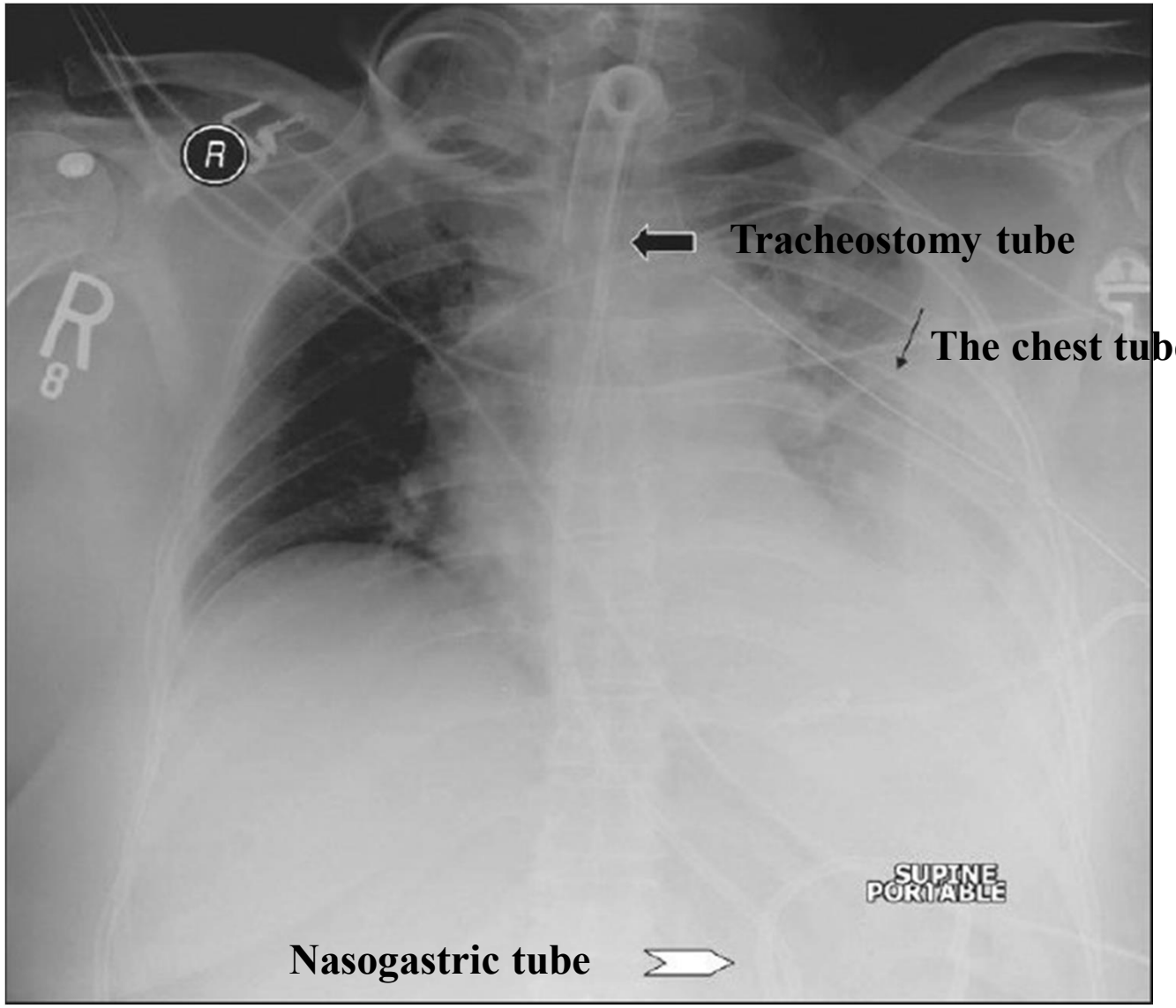
AP view

- Antero-posterior (AP) study refers to films being taken from anterior chest position with the x-ray plate behind the back (AP).
- The heart and mediastinal structures will appear magnified on an AP view of the chest.
- This is commonly used in the ICU “portable films”.

- **Portable radiographs in the ICU** are necessary to determine whether catheters, endotracheal tubes, intra-aortic balloons, and a host of other devices have been correctly placed.
- Portable radiographs are also essential for assessing responses to therapy and for surveying for the presence of new thoracic disease.

A normal AP chest radiograph of an ICU patient

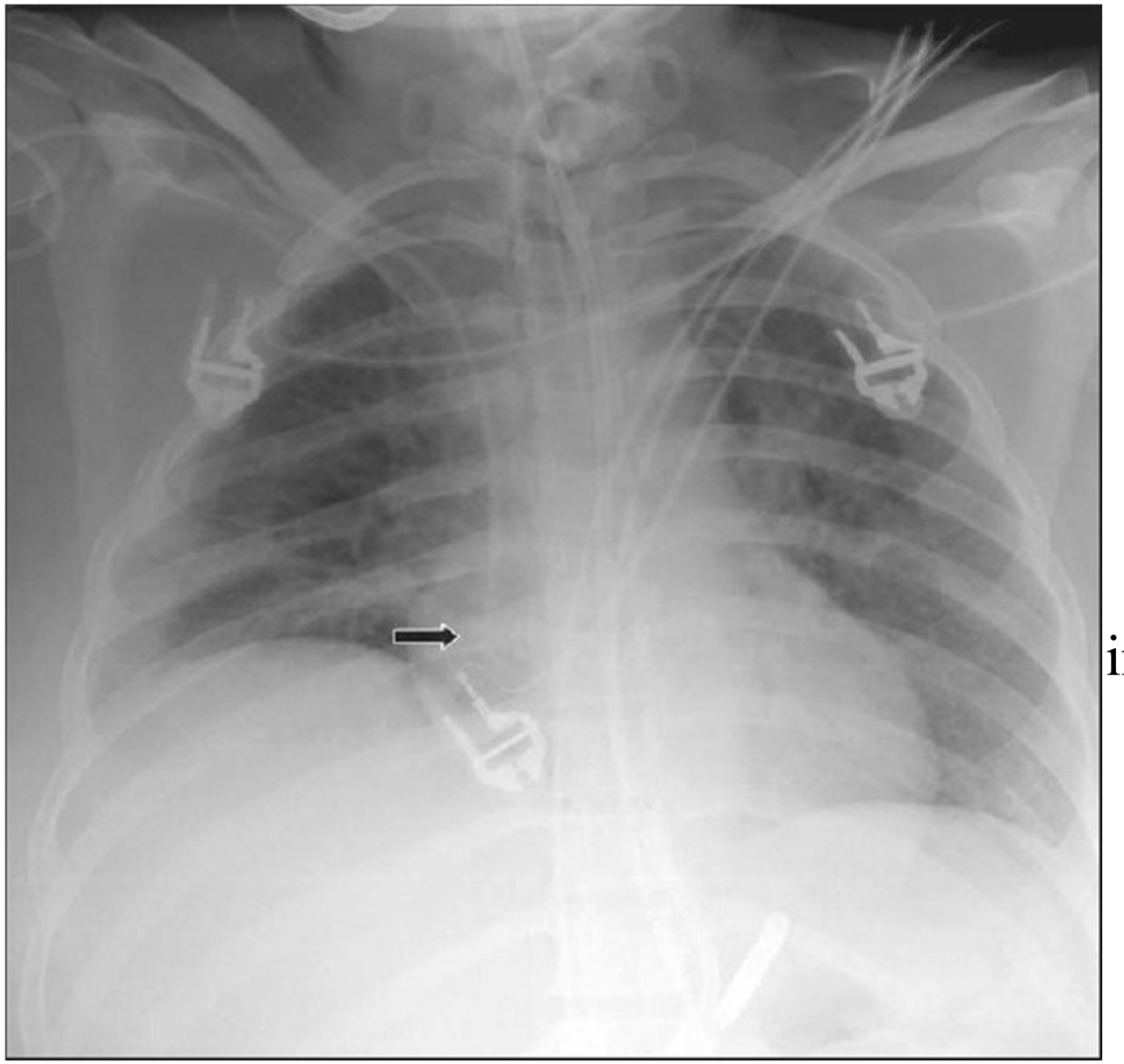
- The sensitivity and specificity of the ICU chest radiograph are low, but its common use stems from studies that have shown that as much as **65%** of ICU chest radiographs reveal a significant pathology that results in a change in patient management.



Tracheostomy tube

The chest tube

Nasogastric tube



AP chest radiograph showing the tip of an intravenous line within the right atrium

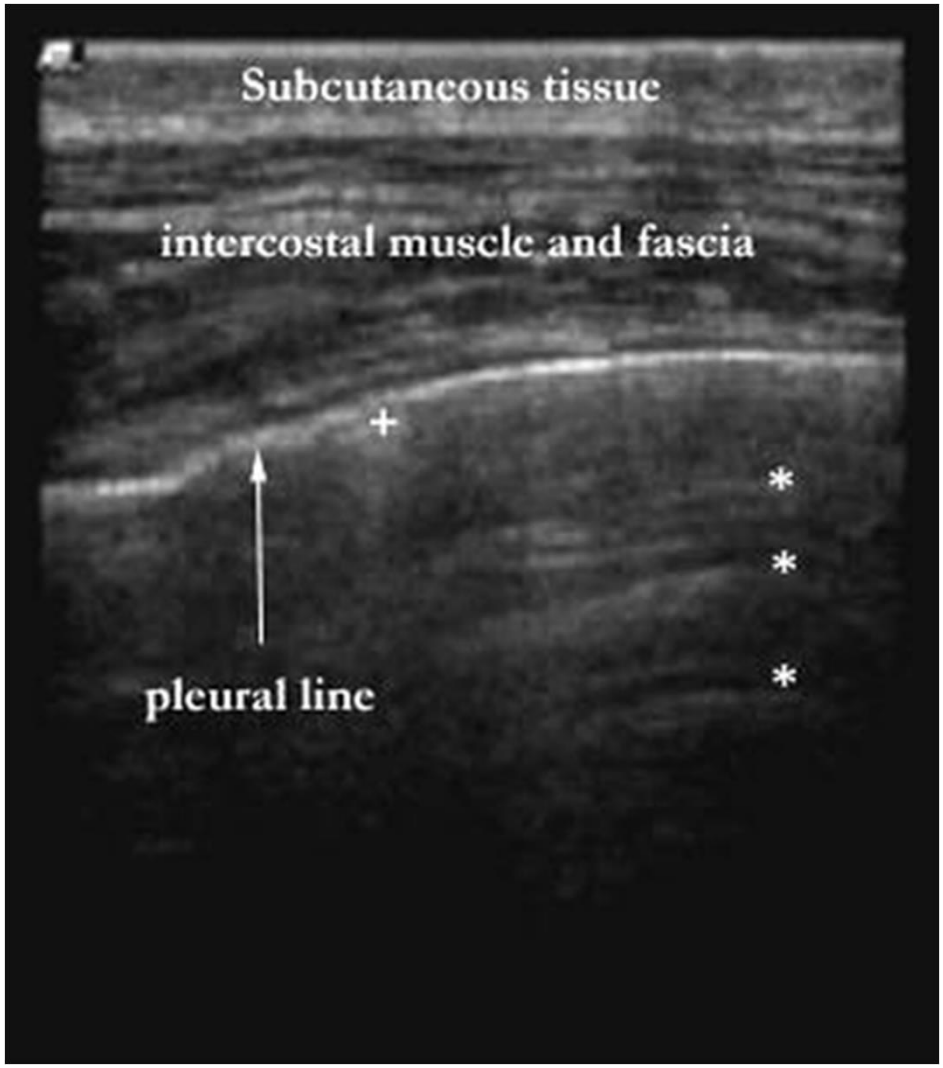
Limitations of conventional radiography

- Abnormal radiographic findings can be quite subtle, however, and in many circumstances the sensitivity and specificity of conventional radiography is limited.
- In such situations, other imaging studies, especially CT, are performed to further investigate abnormalities visible on conventional radiographs or to evaluate patients considered high-risk for a particular condition, but with ***normal chest radiographic results***.
- Inter-observer variation in the interpretation of chest radiographs.

Ultrasonography

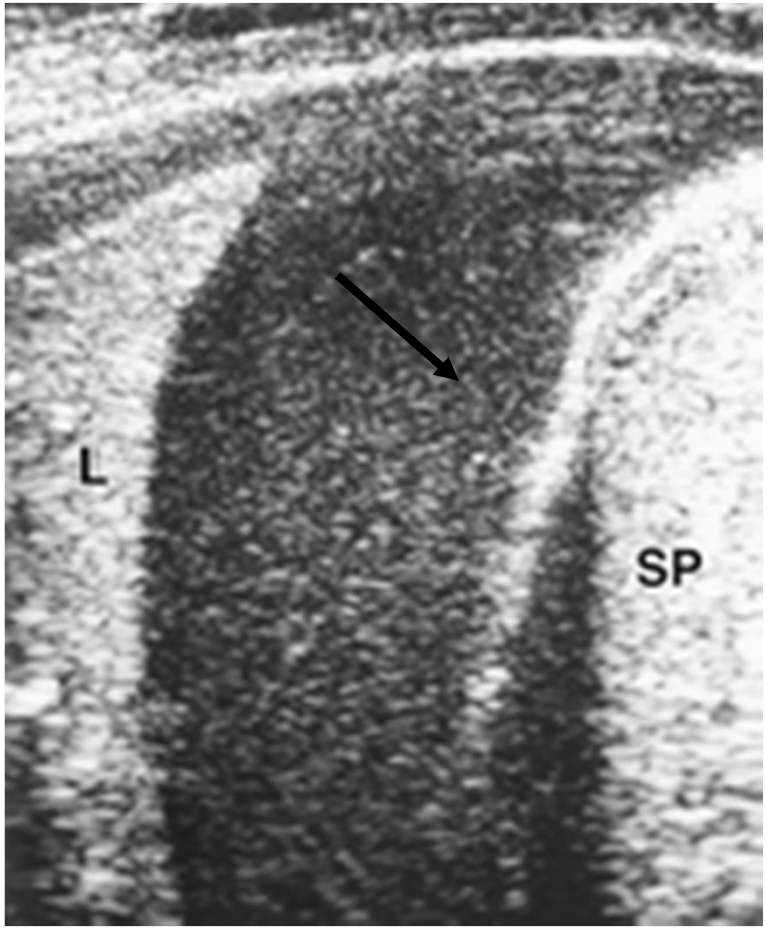
- **Ultrasonography has limited usefulness in thoracic imaging, because the ultrasound beam is reflected at the air-soft tissue interface around the lungs, but some specific uses have been recognized.**

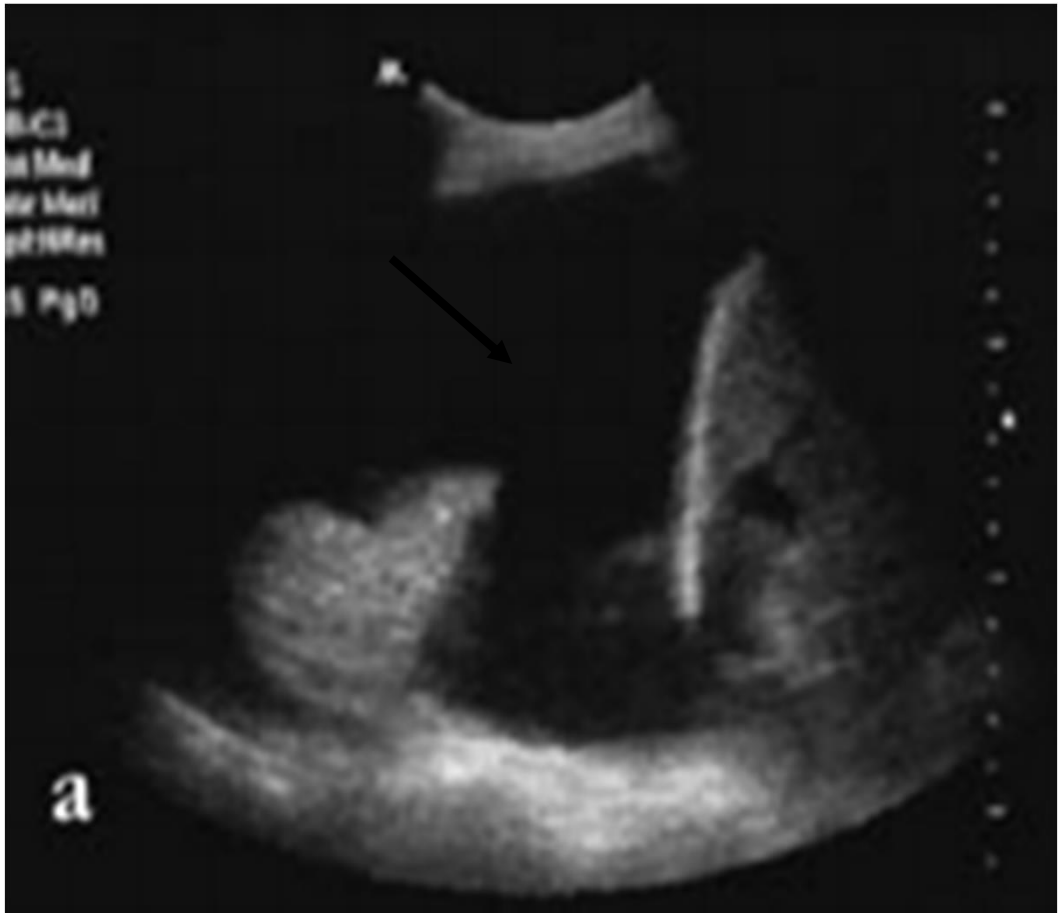
Normal anatomy by the US



- **Ultrasonography is valuable in differentiating pleural effusion from pleural thickening.**

- **Ultrasound-guided thoracentesis is frequently performed when loculated fluid is suspected or after attempts at thoracentesis have failed.**


L
SP


a


pleural thickening

- **Ultrasound is effective in differentiating subphrenic fluid from pleural effusion because the two hemidiaphragms are excellent reflectors of the ultrasound beam and therefore provide a visible boundary distinguishing intrathoracic from subdiaphragmatic spaces .**

- **Pleural neoplasms, mediastinal masses, or parenchymal masses that abut the pleural surface may be biopsied under ultrasonic guidance, provided that no aerated lung intervenes between the lesion and the pleura. The tip of the needle can be guided and identified within the mass, thus confirming appropriate placement before aspiration or biopsy .**

- **US can be used also to differentiate a consolidation from localized pleural effusion.**

ECHO

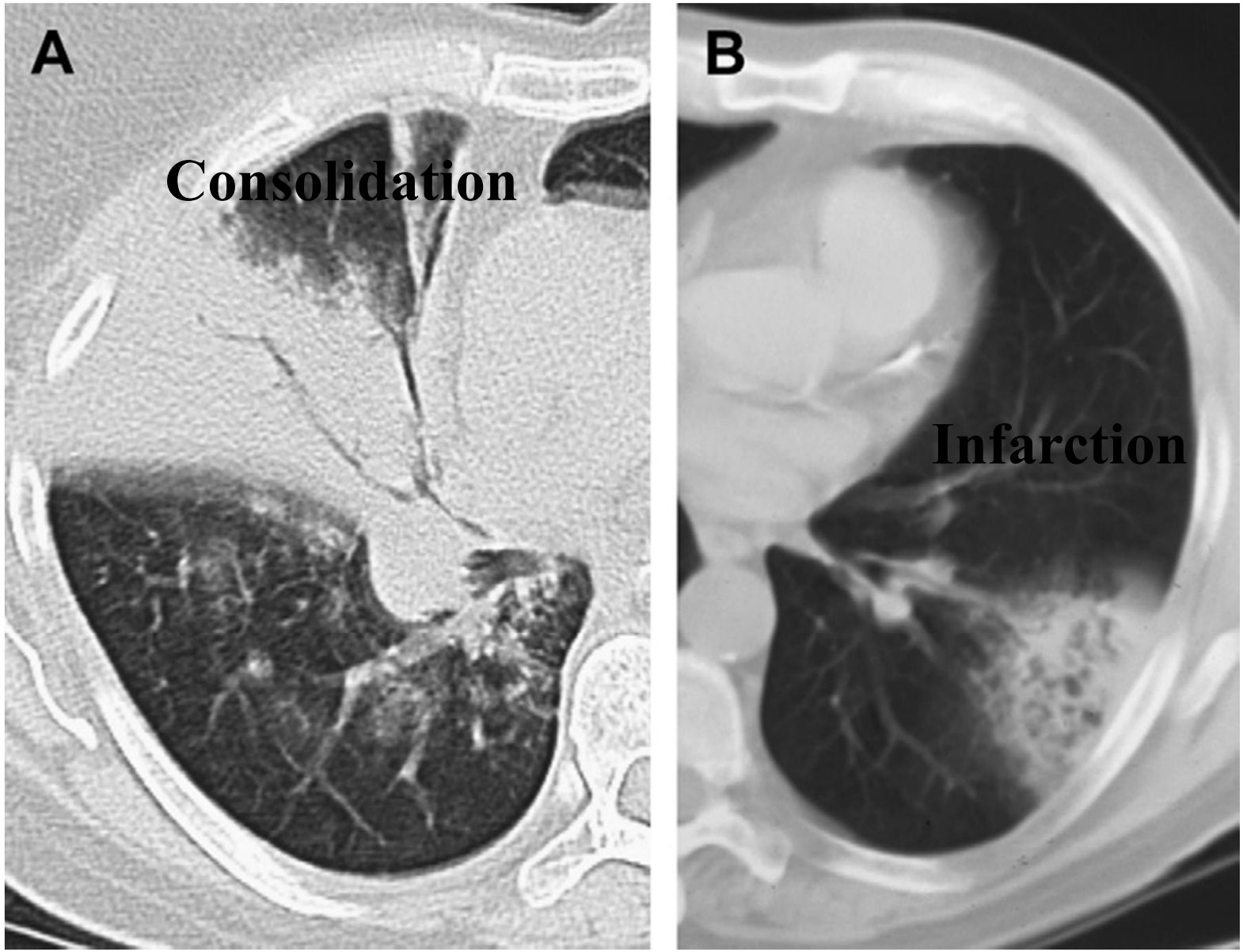
- **US is useful for studying vascular, cardiac, and some mediastinal abnormalities.**
- **Transesophageal sonography can allow imaging of some mediastinal structures and is often performed to assess the thoracic aorta.**

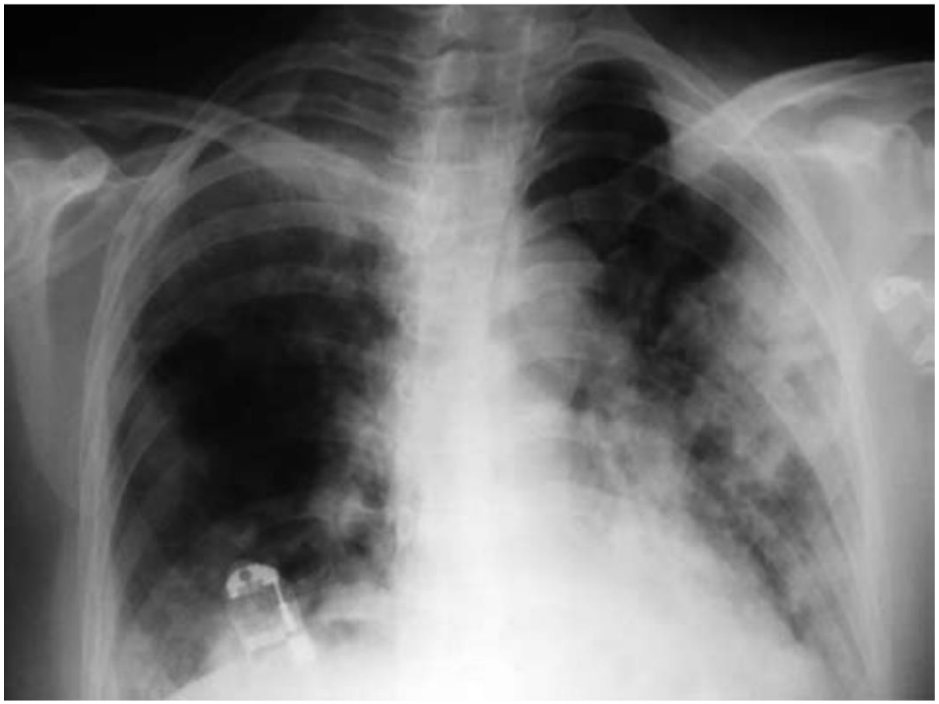
Computed Tomography

Computed Tomography (CT)

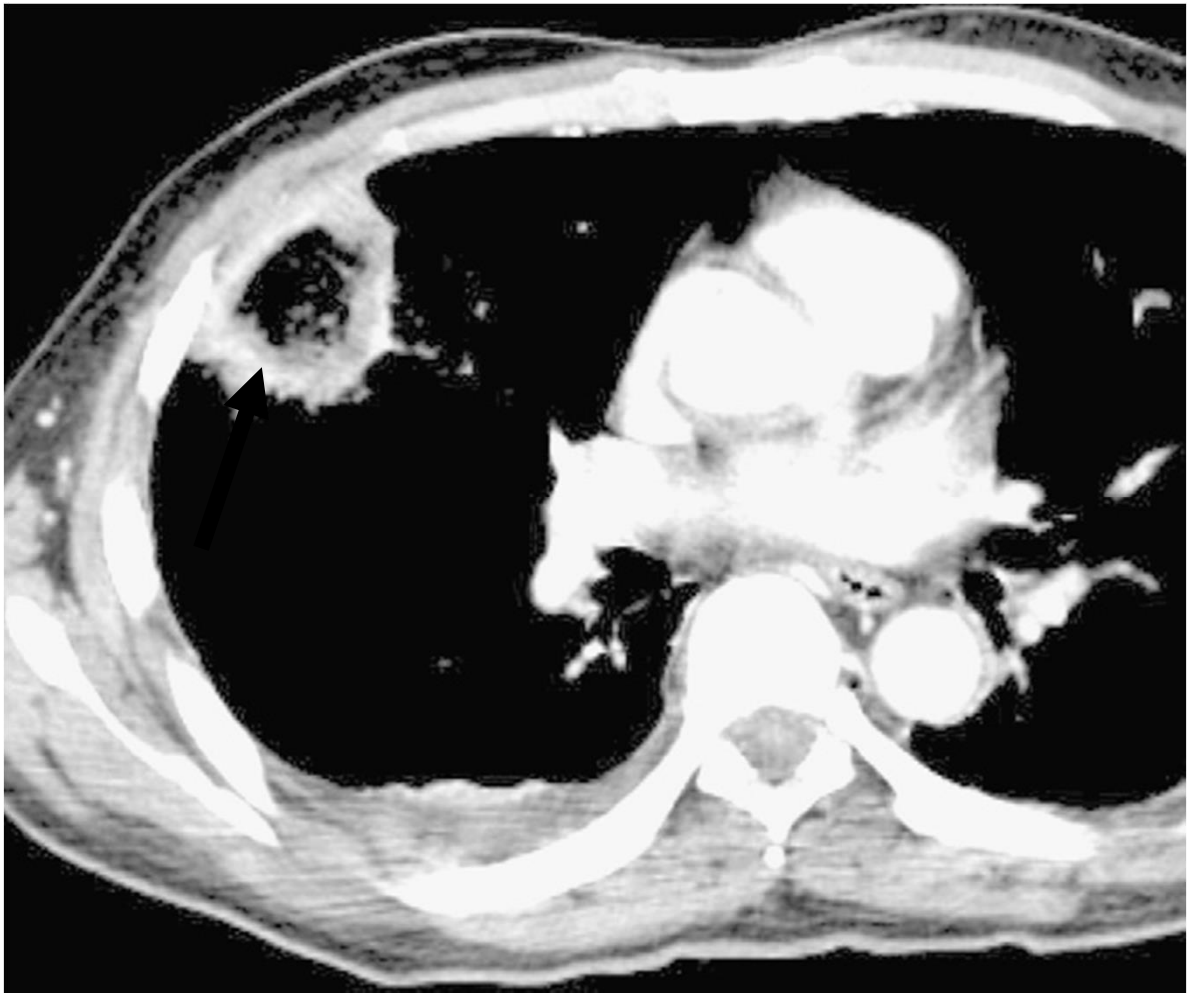
The gold standard for evaluation of chest pathology.

- CT has added great insight into disorders of the lungs, mediastinum, and chest wall.
- Cross-sectional images depicted by CT provide a huge added dimension in the investigation of chest pathology, and the increased resolution permits identification of many findings that are not visible on the plain radiograph.


A
Consolidation
B
Infarction

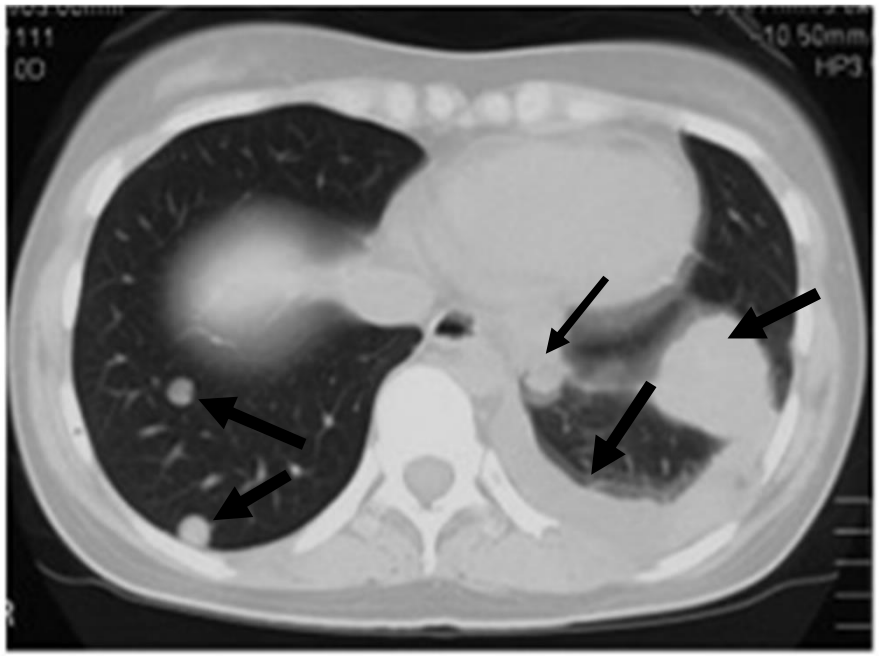


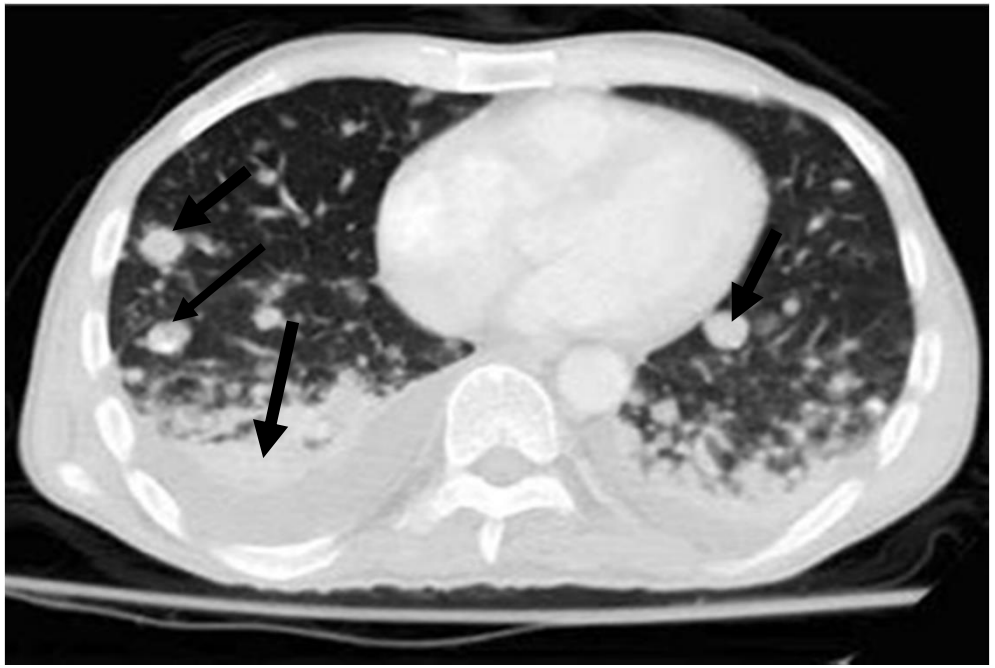
Necrotizing pneumonia caused by community acquired methicillin resistant *Staphylococcus aureus*



Axial CT scan shows right middle lobe excavated consolidation consistent with pulmonary abscess

Metastatic nodules





High-Resolution CT

- High-resolution CT is a special method for evaluating pulmonary pathology.
- High-resolution CT is primarily useful in identifying interstitial lung disease and bronchiectasis.

- High-resolution computed tomography (HRCT) with 1-mm-thick sections obtained at 10-mm intervals has been widely accepted as the imaging standard of reference for assessing diffuse lung disease.
- HRCT has the disadvantage of that only approximately 10% of the lung parenchyma is scanned, the characteristic foci of disease may be missed.

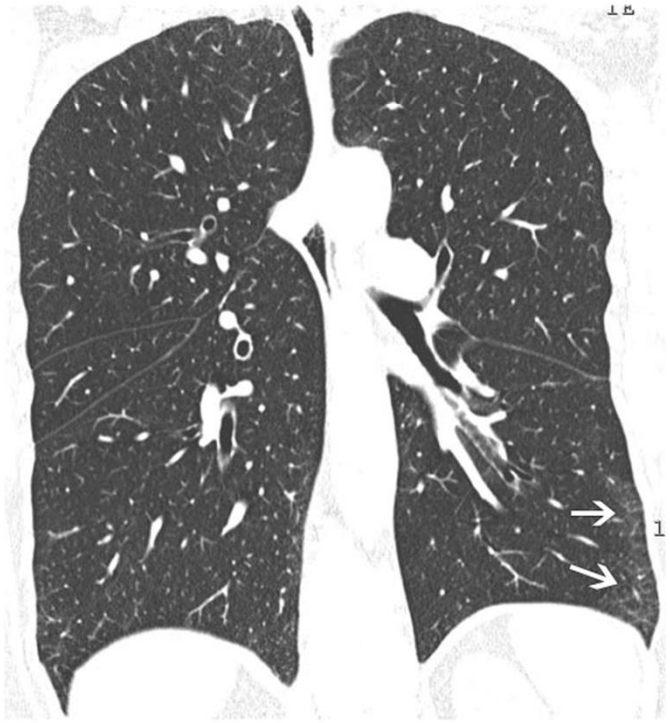
- **Multi–detector row CT (MDCT)** generates isotropic volumetric high-resolution data and allows contiguous visualization of the lung parenchyma.
- The advantages of MDCT are achieved through image reconstruction and post processing tools.

a.

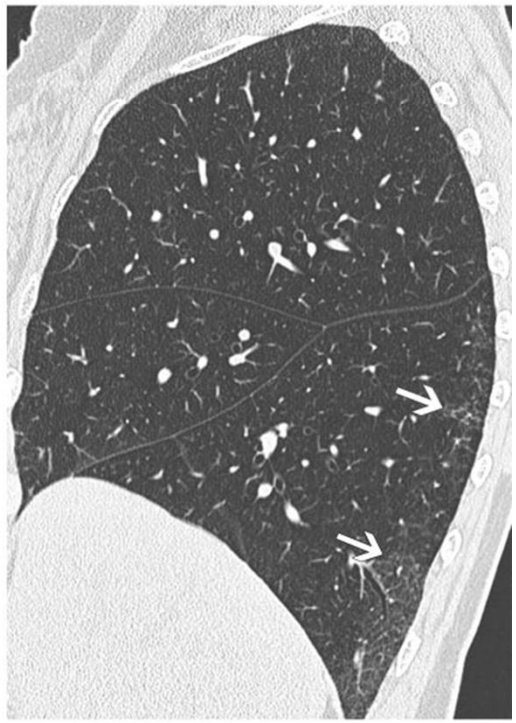
Axial

Axial

Coronal



b.



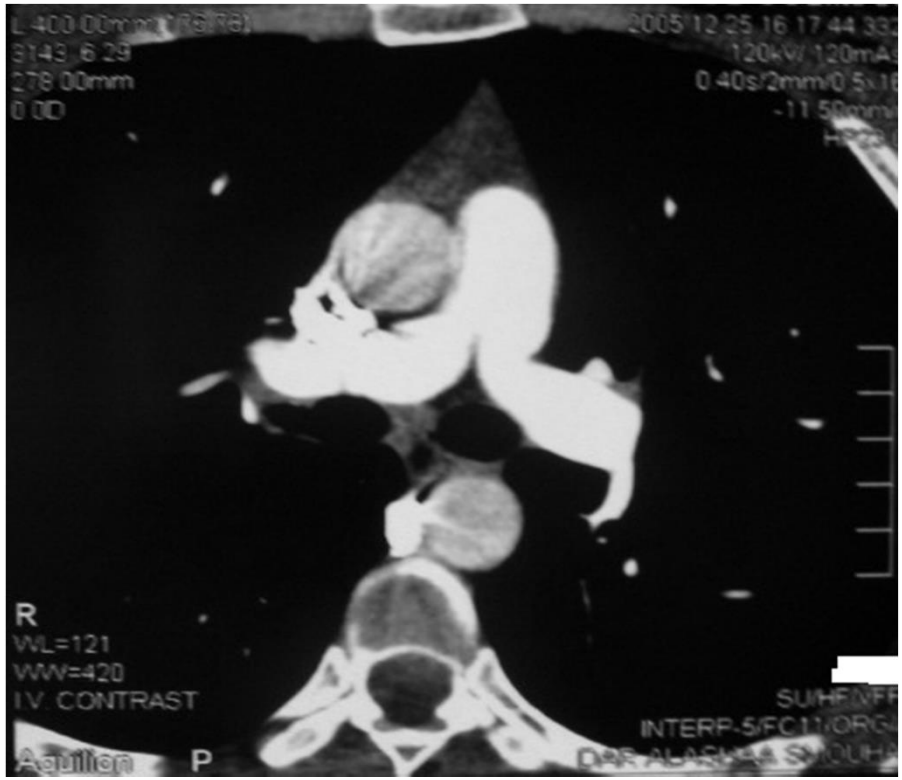
c.

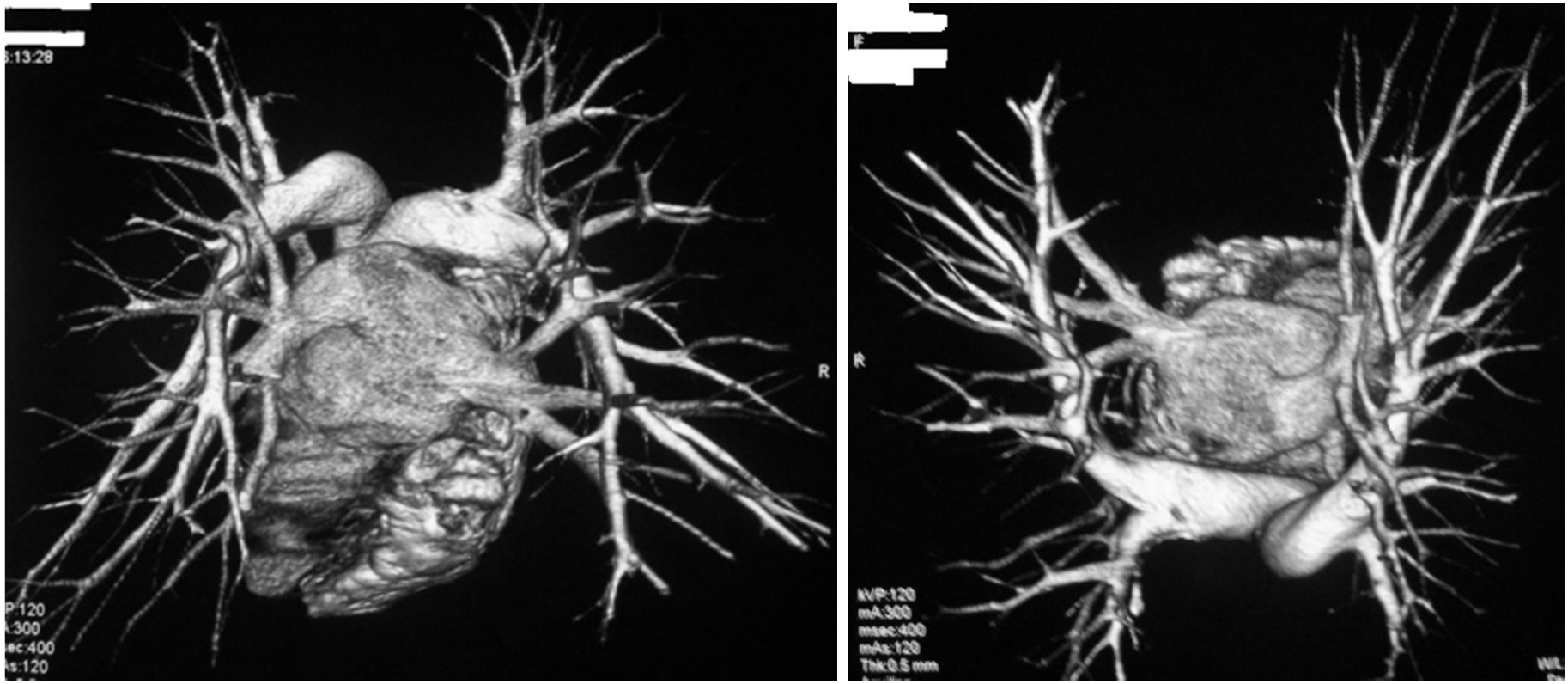
Sagittal

CT Angiography

- CT angiography is an exciting application of helical (spiral) CT technology which has been made especially useful since the emergence of **multidetector imaging**. Axial, multiplanar, reformatted, and three-dimensional images of the vascular system are possible using this technique.

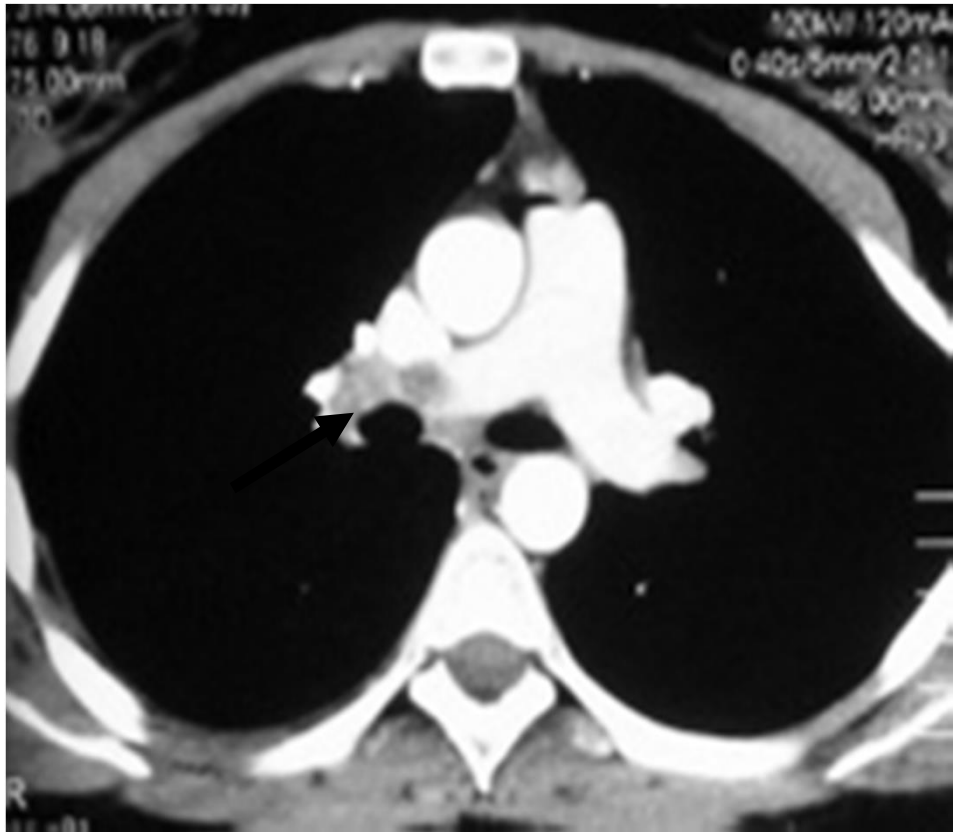
- MDCT pulmonary angiography (axial cut) shows normal both main pulmonary arteries.



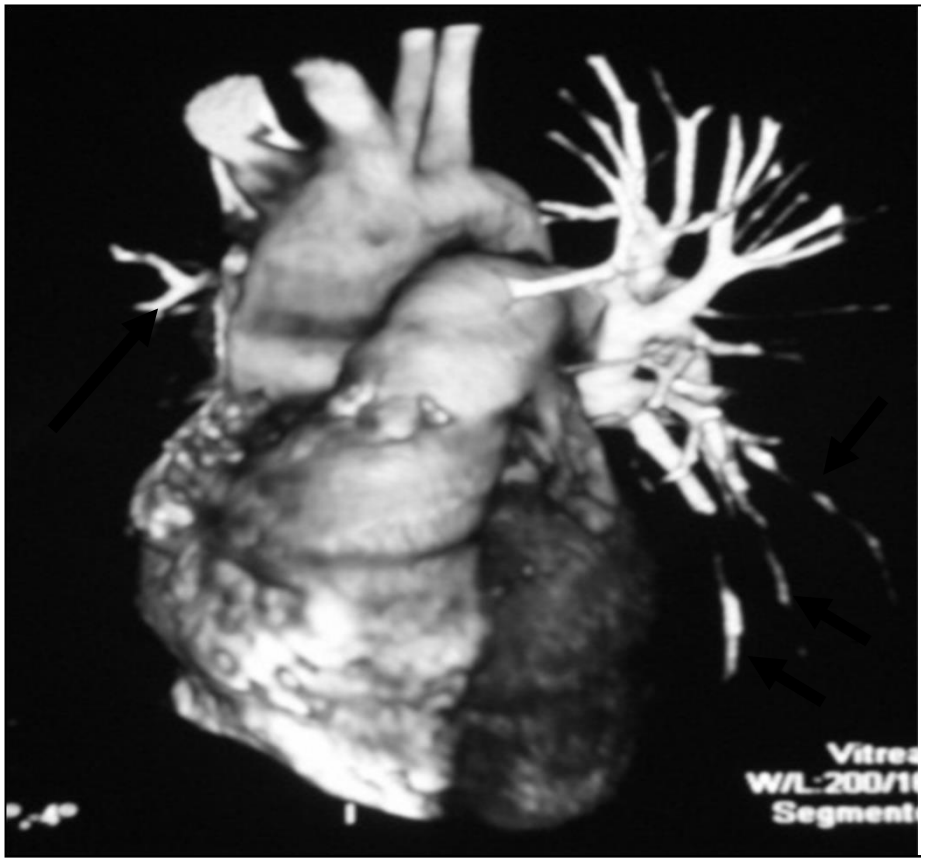


- MDCT pulmonary angiography (3D view) show normal pulmonary arteries (main, lobar, segmental and subsegmental branches).

1. Abnormal MDCT pulmonary angiography

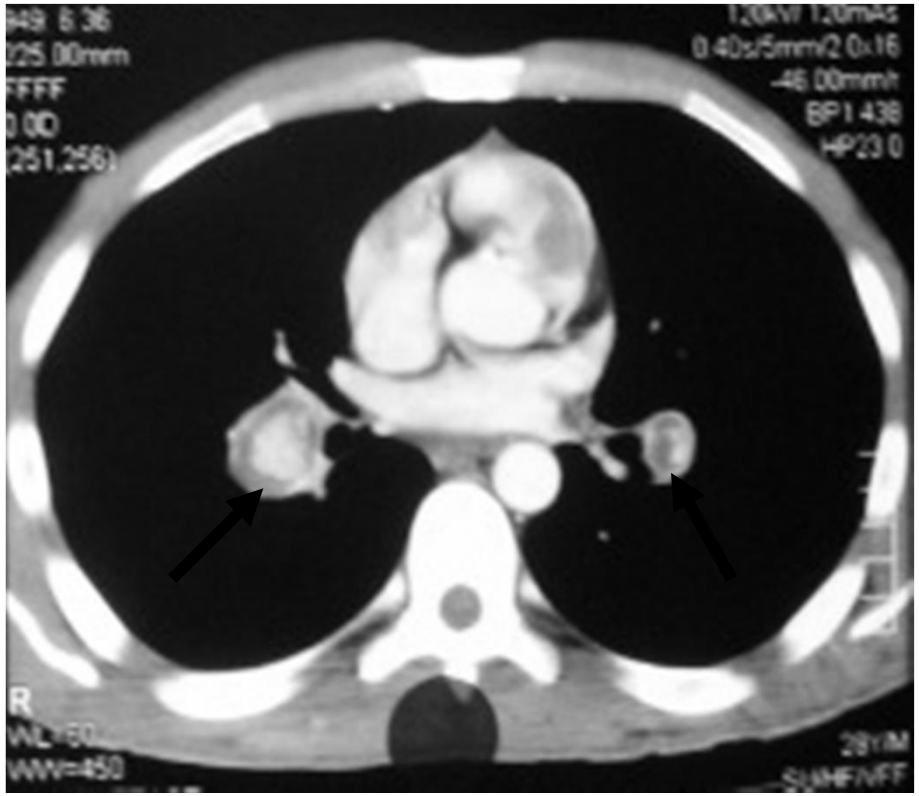


Axial image



3D image

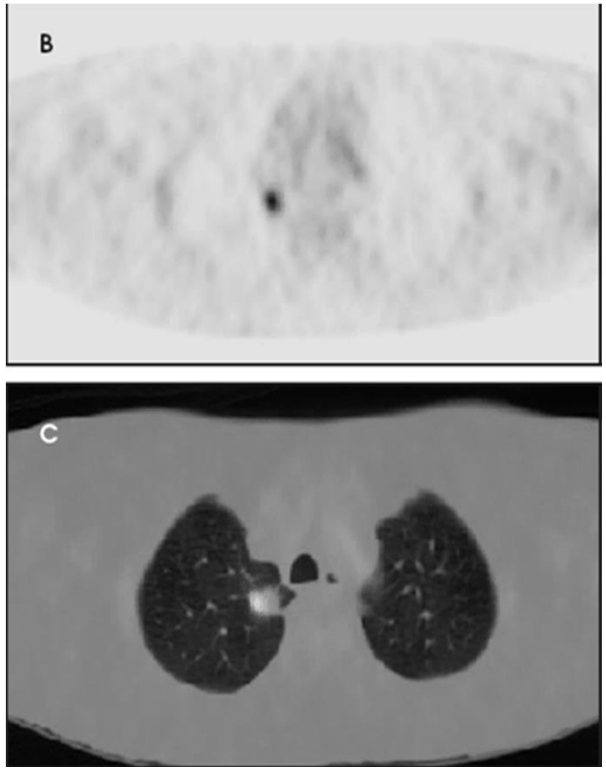
2.



Axial image

Coronal image

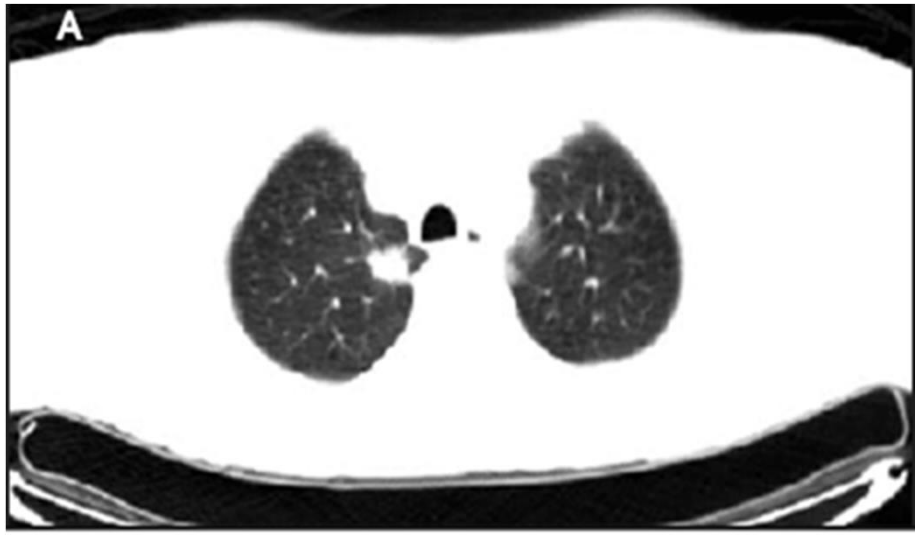
Positron emission tomography (PET Scan)



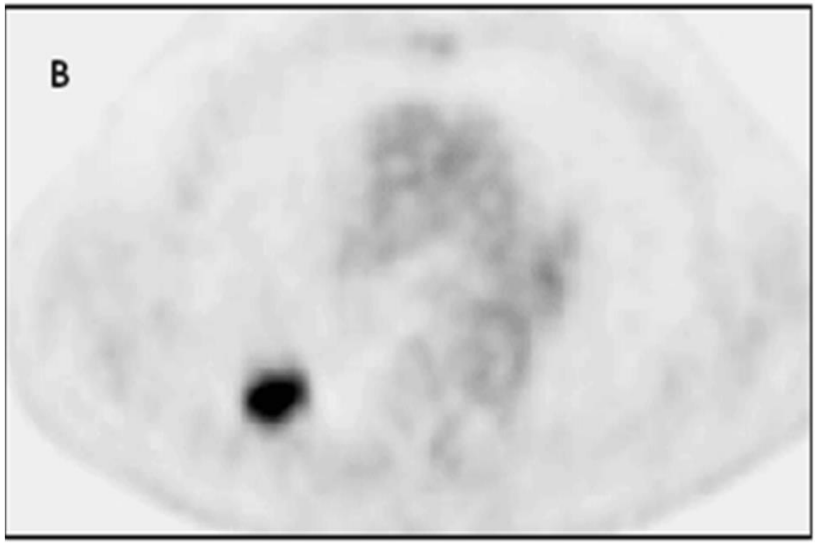
- Recently, positron emission tomography (PET) has come to the aid of clinicians. PET uses a **radioactive glucose analogue**, fluorine-18-labeled fluoro-2-deoxyglucose (FDG), **to map metabolic activity of tissues based on their use of blood glucose**.
- Uptake in the lesion in question is then assessed. Quite often, tumor/blood ratios are used for qualitative interpretation.

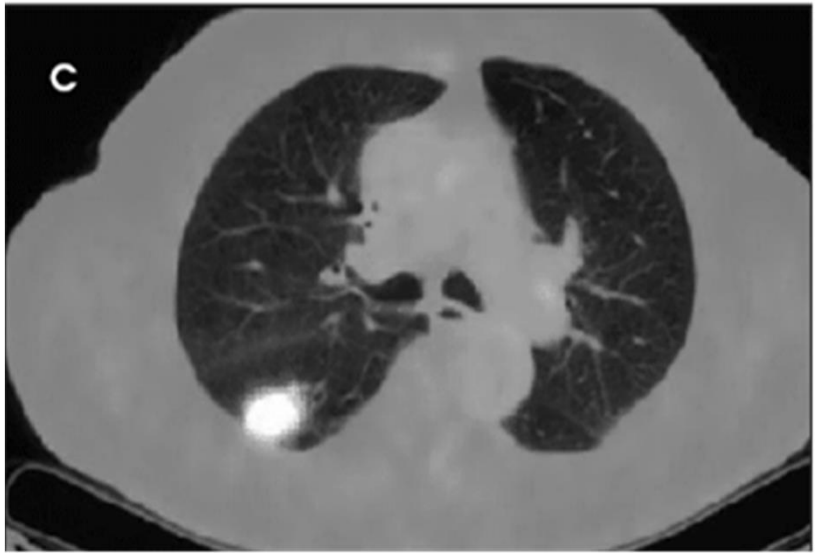
1. First use

- PET scan is used mainly in case of solitary pulmonary nodule. Its aim of use is to differentiate benign from malignant nodule.




A

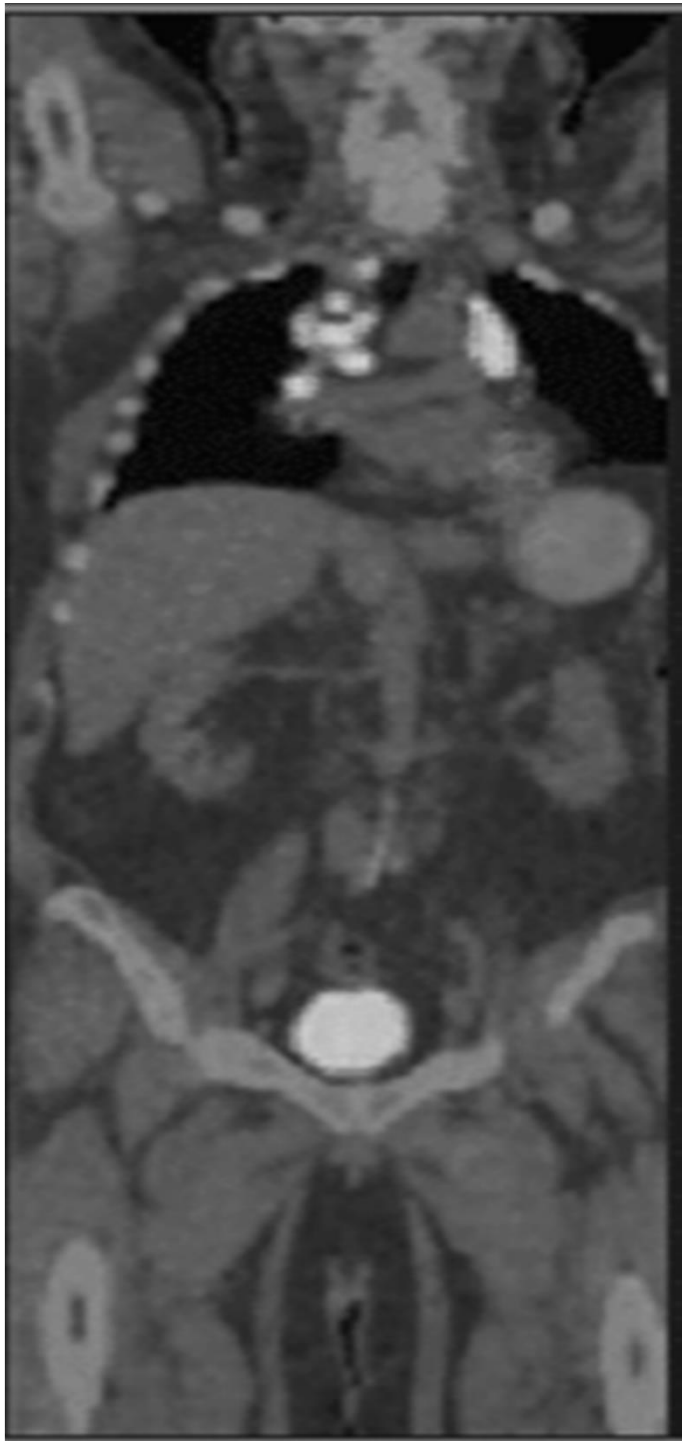

B


C

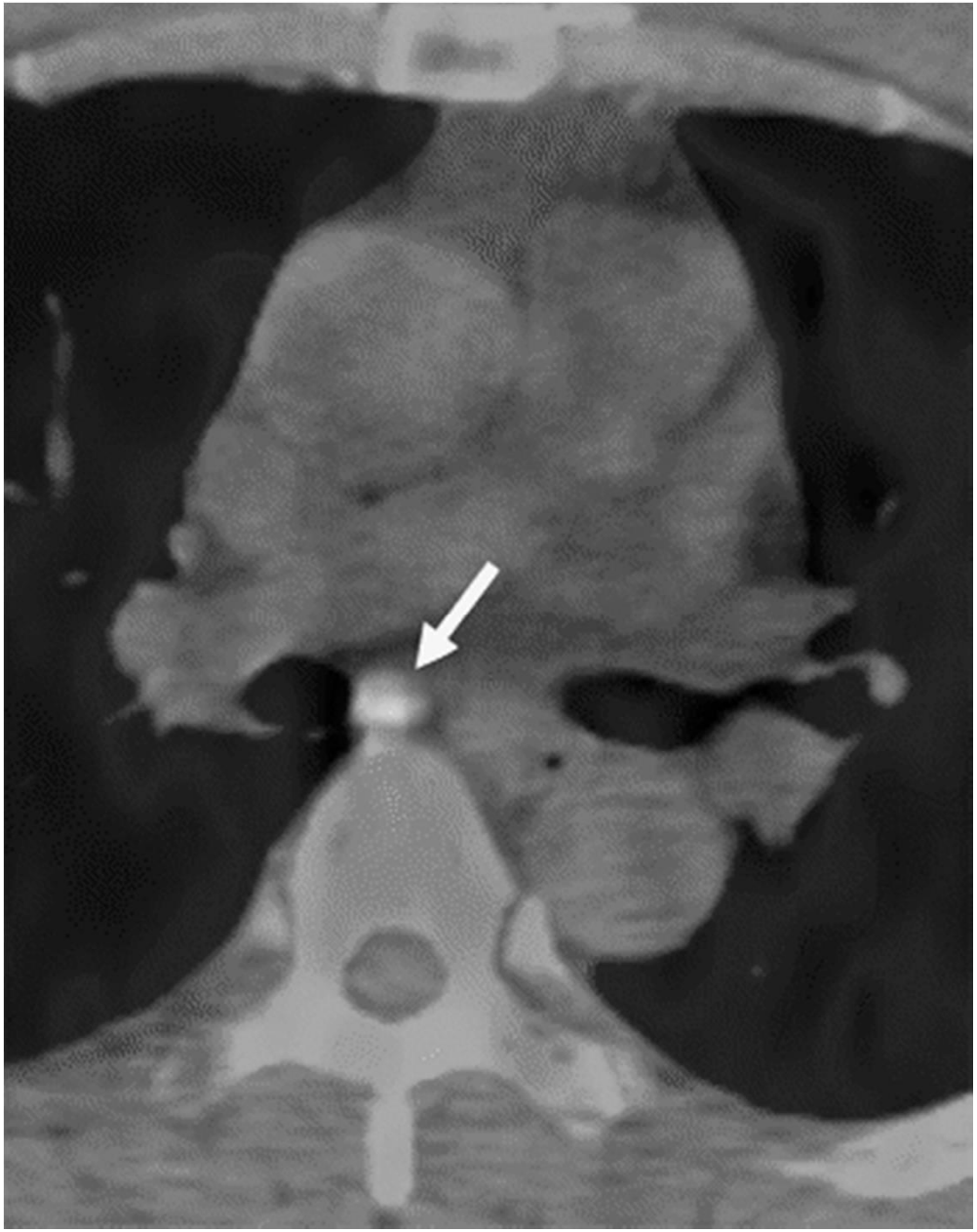
- For the detection of malignant nodules, FDG-PET has an overall sensitivity of 95% to 100% and a specificity of 80% to 89%. However, these numbers may be somewhat lower for smaller (< 1.5 cm) nodules .

2. Second use

- PET has produced **better results in nodal staging of bronchogenic carcinoma** than CT, MRI, endoscopic ultrasound (EUS), or, because of limited accessibility, even mediastinoscopy. The diagnostic accuracy of FDG-PET is 92% compared with 75% for CT.



diffuse mediastinal lymphadenopathy "Active granulomatous disease or lymphoma"



Mediastinal lymph node with markedly increased FDG uptake strongly suggesting malignant node, which proved to contain metastatic adenocarcinoma cells .

Take care ???????

- Inflammatory and granulomatous processes (such as tuberculosis, histoplasmosis, aspergillosis, coccidiomycosis, sarcoid, Wegener's, and even pneumonia) can produce **false-positive results**, especially in cases of a fulminate process.

MRI Chest

MRI

- Although MRI has not had quite as great an impact as CT in the investigation of pulmonary lesions, **it has great usefulness in the study of vascular lesions of the pulmonary vessels and mediastinum.**

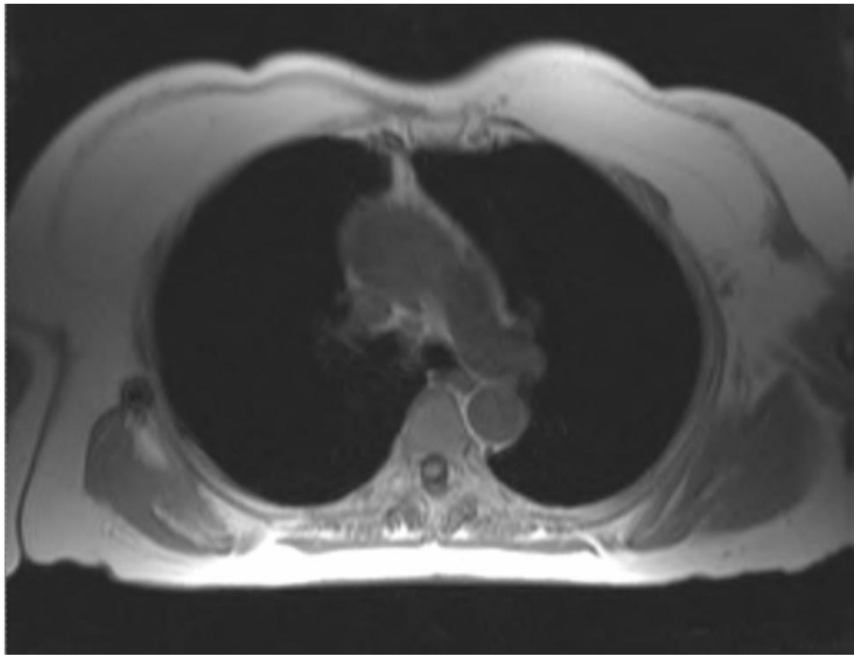
MR imaging of the chest is performed to:

- Assess abnormal growths, including cancer of the lungs or other tissues, which either cannot be assessed adequately with other imaging modalities (typically CT) or which are particularly well-suited to MR imaging.
- Determine tumor size, extent, and the degree to which the cancer has spread to adjacent structures.
- Assess the anatomy and functionality of the heart and its component structures (valves, etc.)

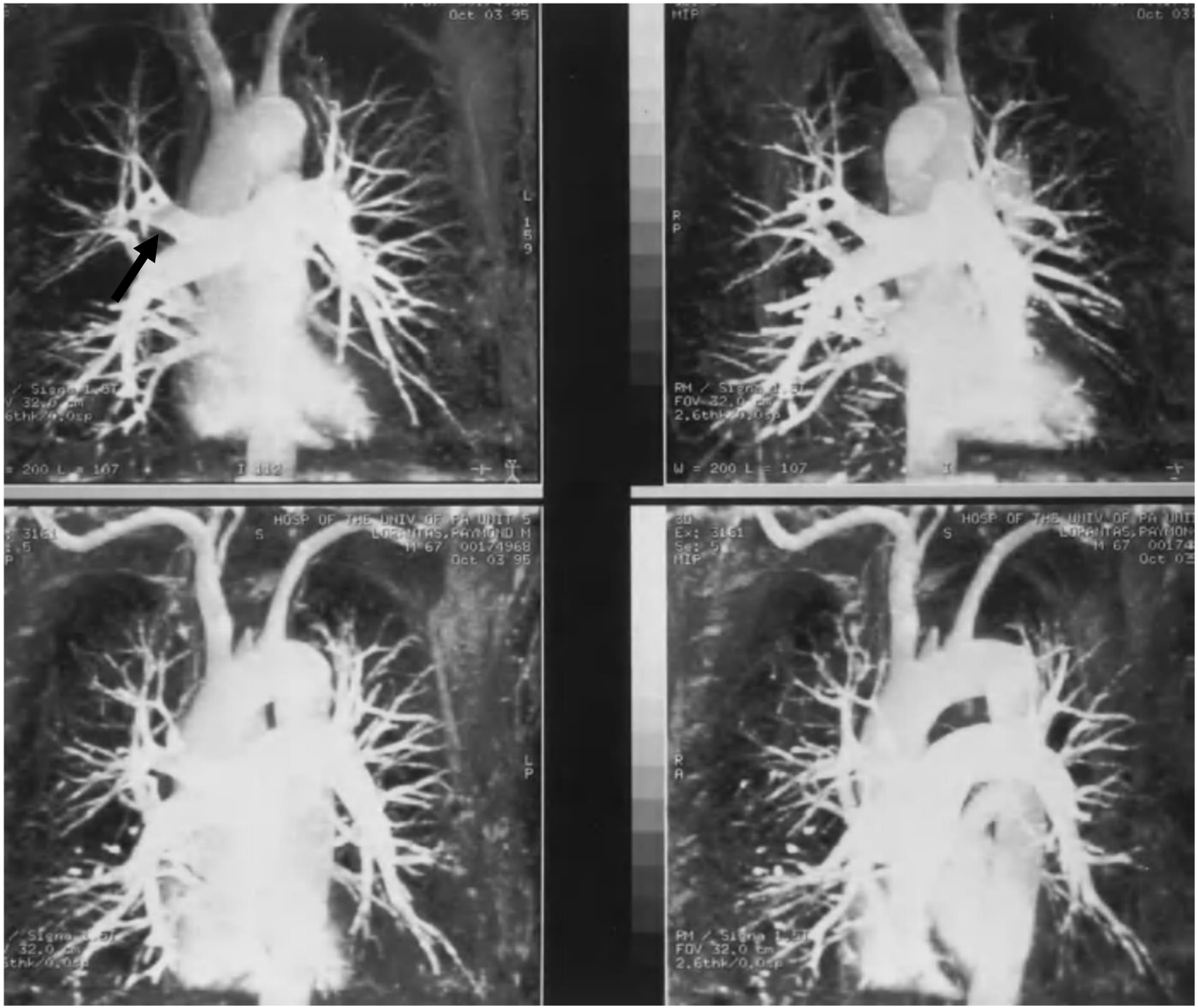
MR imaging of the chest is performed to:

- **Determine blood flow dynamics in the vessels and heart chambers.**
- **Display lymph nodes and blood vessels, including vascular and lymphatic malformations of the chest.**
- **Assess disorders of the chest bones (vertebrae, ribs and sternum).**

- MRI of the chest. Patient is lying on his back. Lungs are black, aorta and pulmonary arteries are grey, shoulder muscles are grey and fat under the skin is white on this sequence.



- The vascular structures are usually **well seen without the use of contrast material**, although intravenous gadolinium can be administered for better vascular evaluation.
- MRI may also have **a major role in the investigation of pulmonary embolism**, either acute or chronic.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Laboratory investigations

1. CBC
2. Arterial Blood gases (ABG)

characteristically reveal hypoxemia, hypocapnia, and respiratory alkalosis(due to hyperventilation).

3. Sputum Examination

For acid fast bacilli and culture& sensitivity.

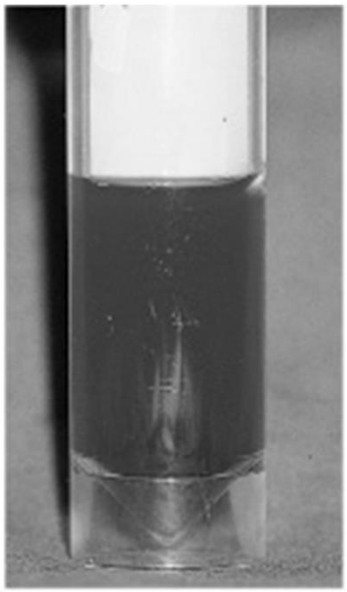
Help to diagnose broncho-pleural fistula:

injection of methylene blue into the pleura is followed by its appearance in the sputum.

Diagnostic Aspiration of pleural effusion

- Aim:
- 1-To examine physical, chemical, cytological& bacteriological characters.
- 2-For culture& Sensitivity.
- 3-To D.D bet Transudate& Exudate effusion.
- 4-To identify special subtypes of effusion for ex:
- *Hemorrhagic *Chylous *Tuberculous
- *Malignant *Collagenic *Post pneumonic
- *Empyema *Myxedema.

Diagnostic Aspiration of pleural effusion



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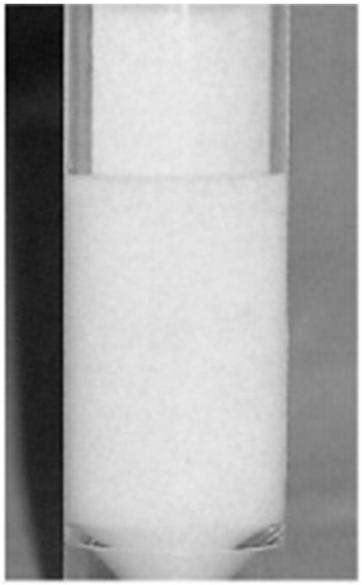

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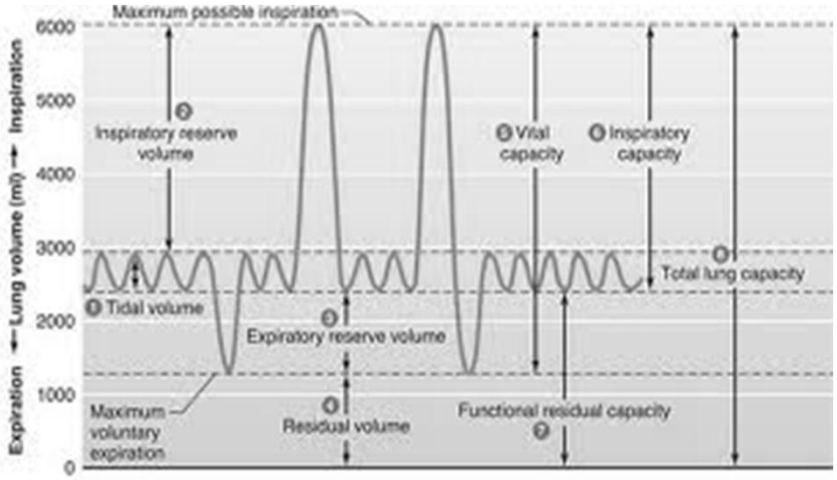
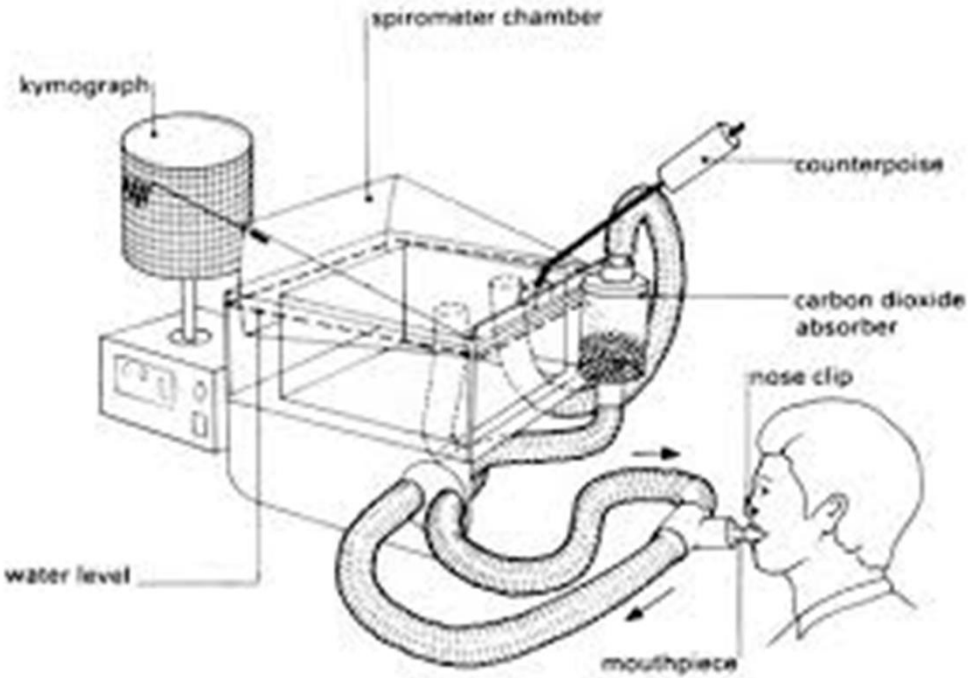
Pulmonary function tests

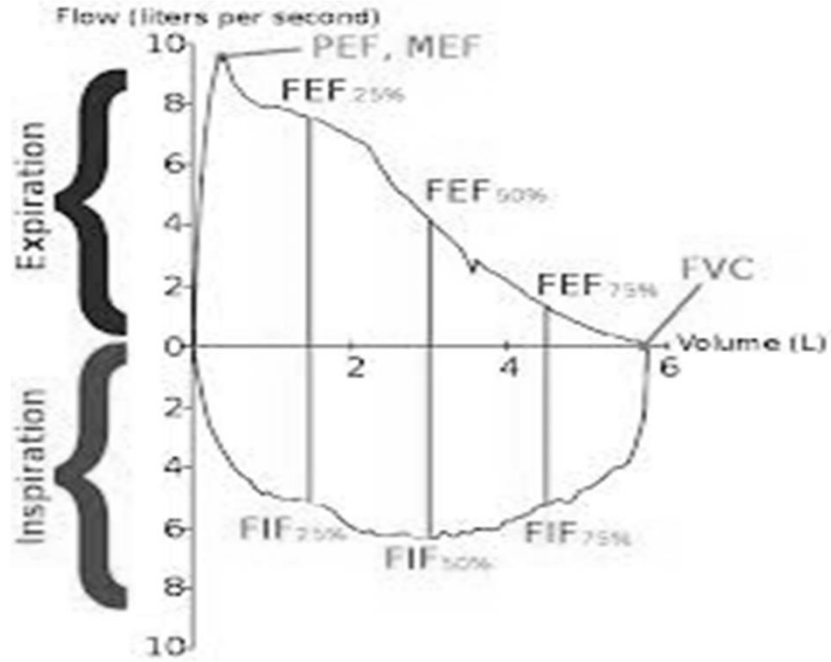
Spirometry

- spirometry is adequate to diagnose the presence of lung disease.
- Categorization of the physiology of lung disease into either **obstructive or restrictive** allows development of a differential diagnosis.
- **Lung volumes and diffusion** refine the diagnosis.
- Testing of **muscle strength and bronchial provocation** aid in difficult cases.

Spirometry

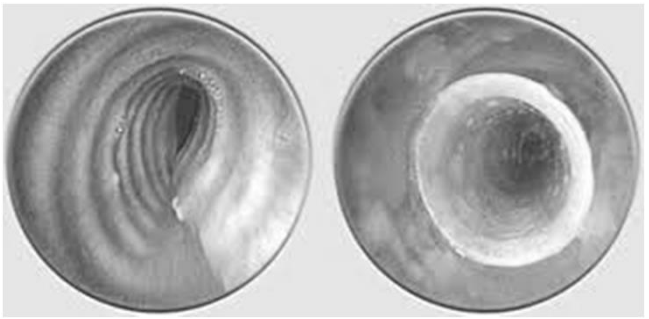

Maximum possible inspiration
Expiration ← Lung volume (ml) → Inspiration
6000
5000
4000
3000
2000
1000
0
Inspiratory reserve volume
Vital capacity
Inspiratory capacity
Total lung capacity
Tidal volume
Expiratory reserve volume
Maximum voluntary expiration
Residual volume
Functional residual capacity


spirometer chamber
kymograph
counterpoise
carbon dioxide absorber
nose clip
water level
mouthpiece


Flow (liters per second)
PEF, MEF
FEF 25%
FEF 50%
FEF 75%
FVC
Volume (L)
Expiration
Inspiration
FIF 25%
FIF 50%
FIF 75%
10
8
6
4
2
0
2
4
6

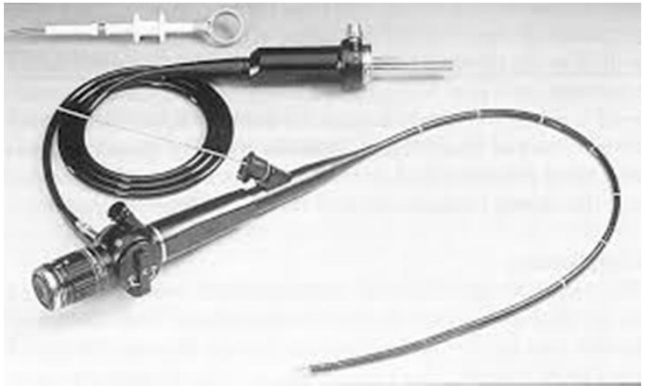
Procedures in pulmonary medicine.

Bronchoscopy



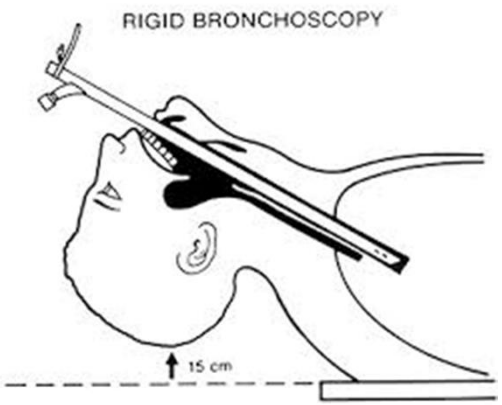
- Diagnostic and therapeutic procedure that permits direct visualization of the tracheo-bronchial lumen with the help of bronchoscope and specialized optical devise .

- Types : rigid and fiberoptic bronchoscopy



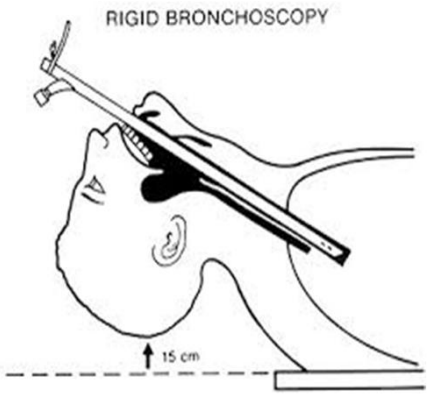
Rigid bronchoscopy

- Rigid bronchoscopy is an invasive procedure that is utilized to visualize the oropharynx, larynx, vocal cords, and tracheo-bronchial tree. It is performed for both the diagnosis and treatment of lung disorders.



Rigid bronchoscopy

- The procedure may be performed in an endoscopy suite
  - Under intravenous sedation
  - General anesthesia : recommended
    - Lengthy procedures
    - Some pediatric patients
    - Patients who can not cooperate

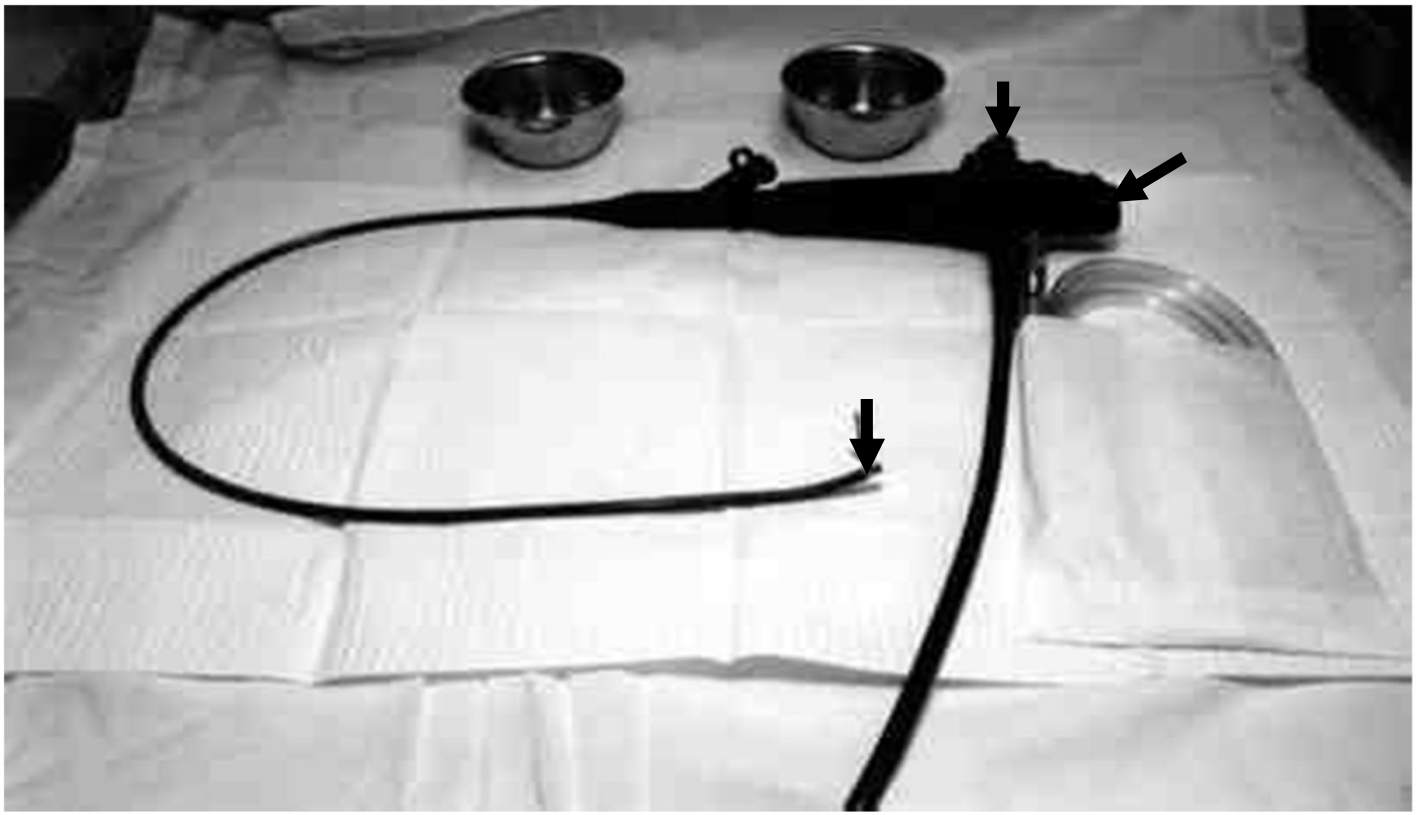


- but more appropriately in the operating room, and rarely in the ICU.

Indications

- **Bleeding or hemorrhage : improved suctioning, continuous airway control, larger lumen , packing, clearing clots.**
- **Foreign body extraction,**
- **Deeper biopsy specimen when fiber-optic specimen is inadequate,**
- **Dilation of tracheal or bronchial strictures**
- **Relief of airway obstruction**
- **Insertion of stents**
- **Pediatric bronchoscopy.**
- **Tracheobronchial laser therapy or other mechanical tumor ablation.**

Flexible fiberoptic bronchoscope (FOB)



The arrow shows the tip of the bronchoscope which has a light and camera to allow the doctor to carefully push it through the nose and then into the lungs.

Advantages of FOB

- It can be inserted either orally, nasally or through a tracheostomy stoma
- Visualizes apical segments of upper lobes as well as segmental and subsegmental bronchi in all lobes.
- It can be done in an outpatients setting or even by the patients bedside.
- It can be performed with the patients under light sedation and with application of topical anesthesia.
- Many ancillary instruments are available for FOB

Indications of FOB

- **For Endobronchial Symptoms or Signs**
  Symptoms and signs of endobronchial disease are the most common indications for a bronchoscopy.
  - **Chronic cough**
  - **Hemoptysis**
  - **Atelectasis**
  - **Obstructive pneumonia**
  - **Localized wheezing**
- **Evaluation of symptomatic patients with normal x-ray.**

- **FOB is inferior to rigid bronchoscopy in**

- **Aspirating secretions**
- **Managing bleeding**
- **F.B extraction.**

Contraindications

- **Relative contraindications include**
  - **Uncontrolled coagulopathy**
  - **Extreme ventilatory and oxygenation demands,**
  - **Tracheal obstruction to the novice operator.**

Complications

Most potential complications of rigid bronchoscopy can be avoided. These include

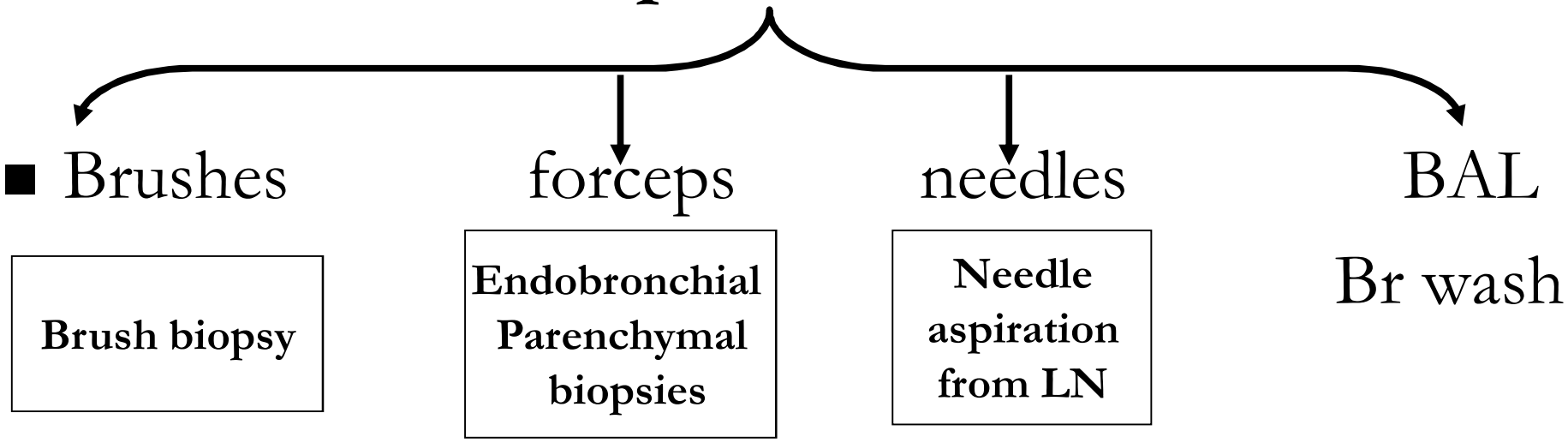
- **Injury to the teeth or gums,**
- **Tracheal or bronchial tears**
- **Severe bleeding.**

▪ **Complication rates should be < 0.1%. Procedure-related mortality is rare.**

- **Types of bronchoscopic procedures to obtain tissue samples**

  Brochoalveolar lavage (BAL)
  Bronchial washing
  Brush biopsy
  Endobronchial and parenchymal biopsies
  Trans-bronchial needle aspiration from LN immediately adjacent to airways

Bronchoscopic Instruments & procedures



- **Bronchoalveolar lavage (BAL)**
  - **Yield specific infection (PCC, TB)**
  - **Identification of inflammatory cells**
  - **Diagnosis of malignancy (cytology)**

Autofluorescence bronchoscopy

- Initial bronchoscopic examination is performed using conventional white light bronchoscope.
- Under blue light illumination different wavelength of light emitted by

Normal respiratory mucosa
(appear green)

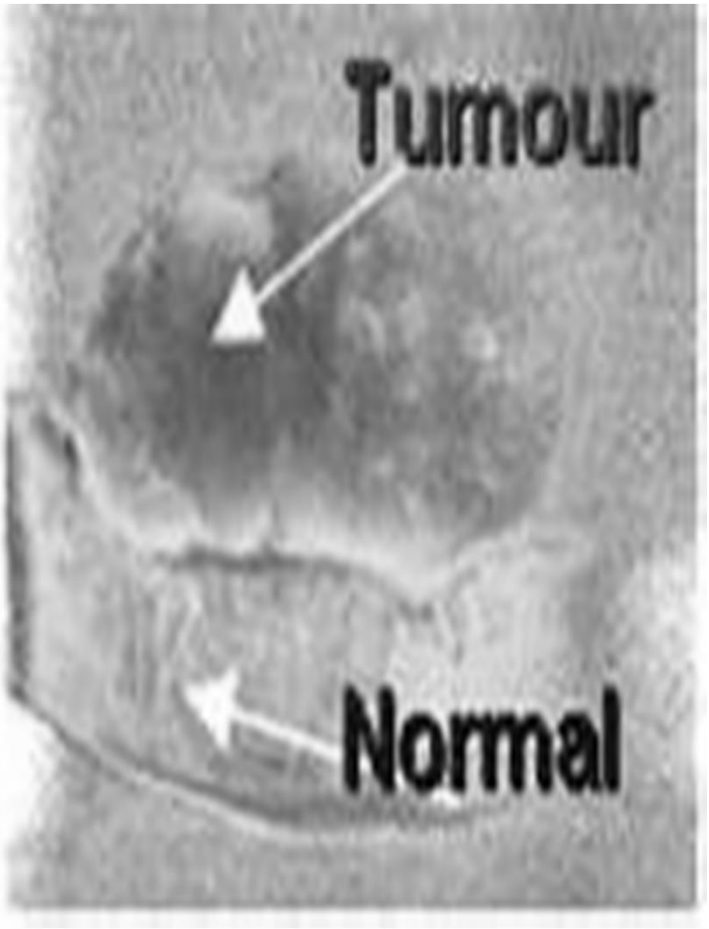
Abnormal respiratory mucosa
(cancerous or precancerous)

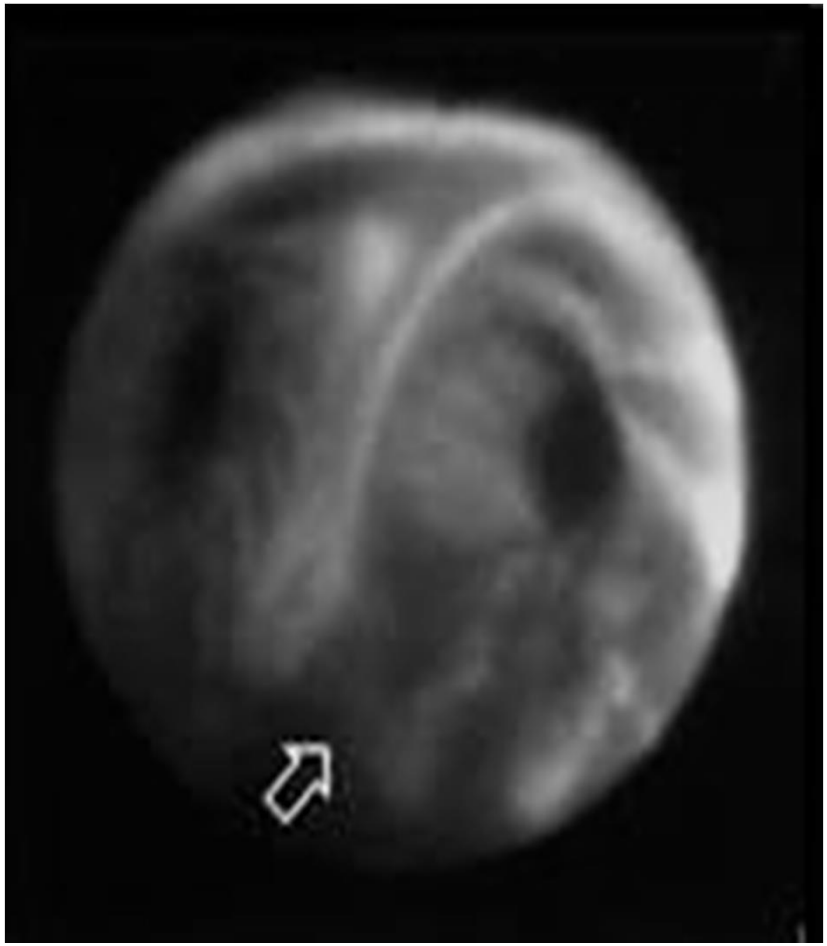
(appear reddish brown))

brush or biopsy are obtained

- **Indications of autofluorescence bronchoscopy**
  - **Suspected lung cancer by abnormal sputum cytology findings.**
  - **Inspection for synchronous tumors,**
  - **Surveillance following cancer resection,**
  - **Primary screening among high-risk patients.**

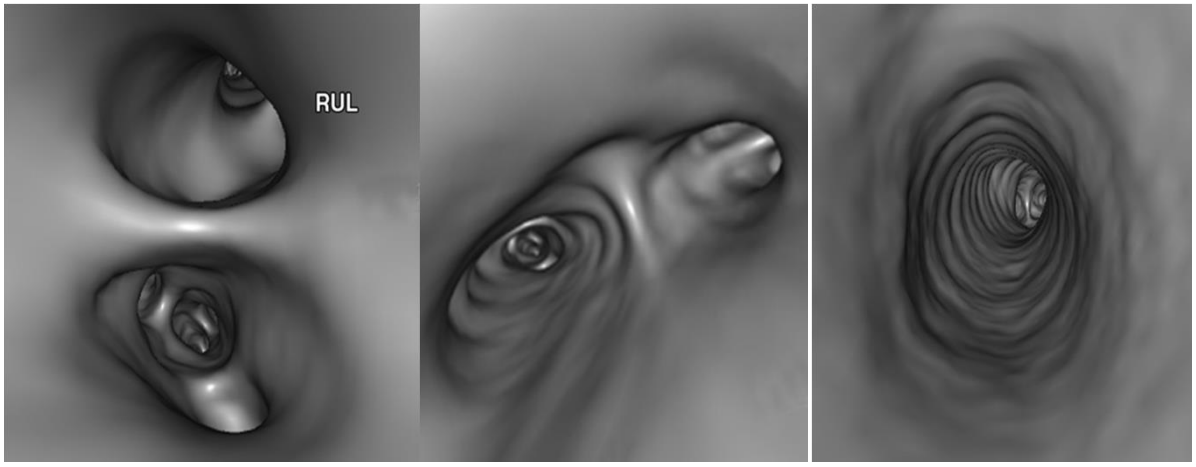
Autofluorescence Bronchoscopy





Virtual bronchoscopy (VB)

- Virtual bronchoscopy (VB) is a computer-generated 3D CT post-processing technique that produces high-resolution images of the tracheobronchial tree and endobronchial views that simulate the findings at conventional bronchoscopy.



Pleural Investigative Tools

Thoracentesis (pleural aspiration)

- Bacteriological & Cytological examination of pleural fluid
- is diagnostic in approximately 60% of patients presenting with effusion secondary to malignant disease.

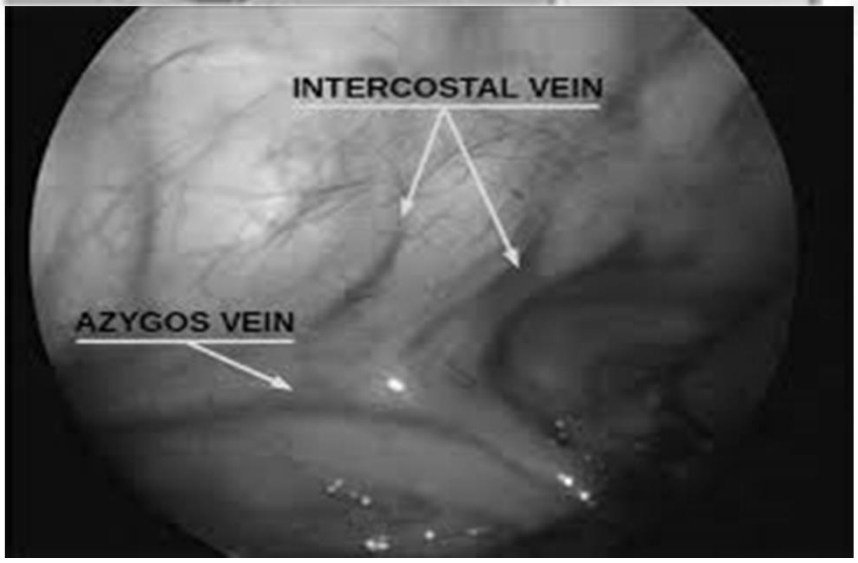
Trans-thoracic needle aspiration/biopsy guided by image techniques

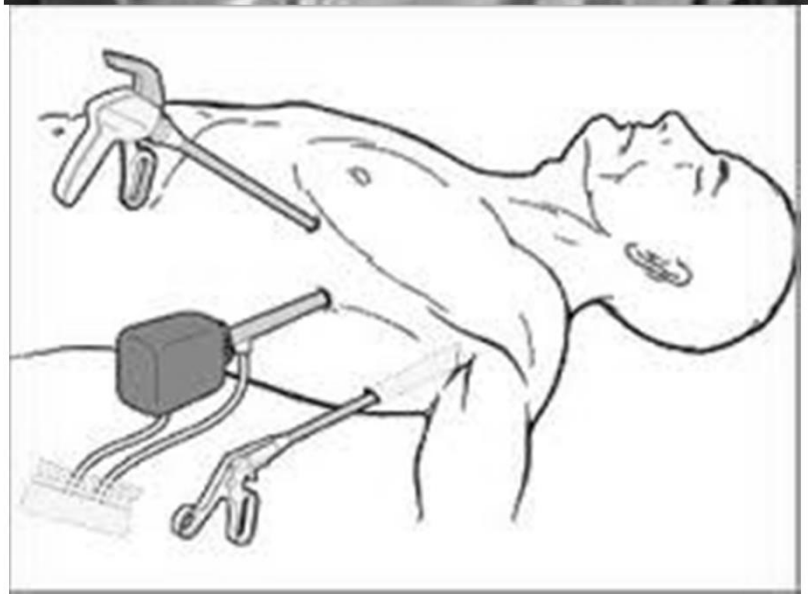
It might be indicated in cases with a clear parietal pleura thickening or when focal areas of pleural nodularity are seen on ultrasound or CT examination.

Thoracoscopy

- Thoracoscopy performed under local anaesthesia
- In the endoscopy suite
- With the use of nondisposable instruments,
- Used generally for diagnostic purposes.

Thoracoscopy & Video-assissted thoracoscopy (VATS)

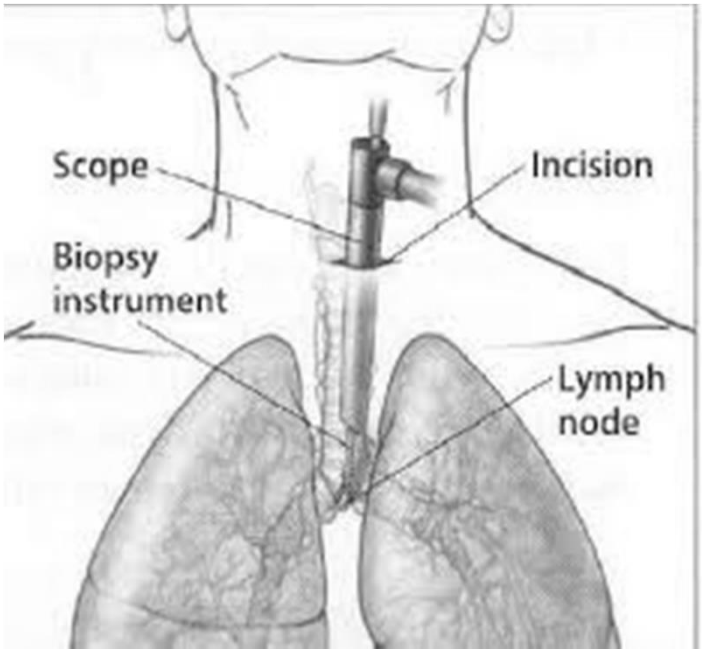


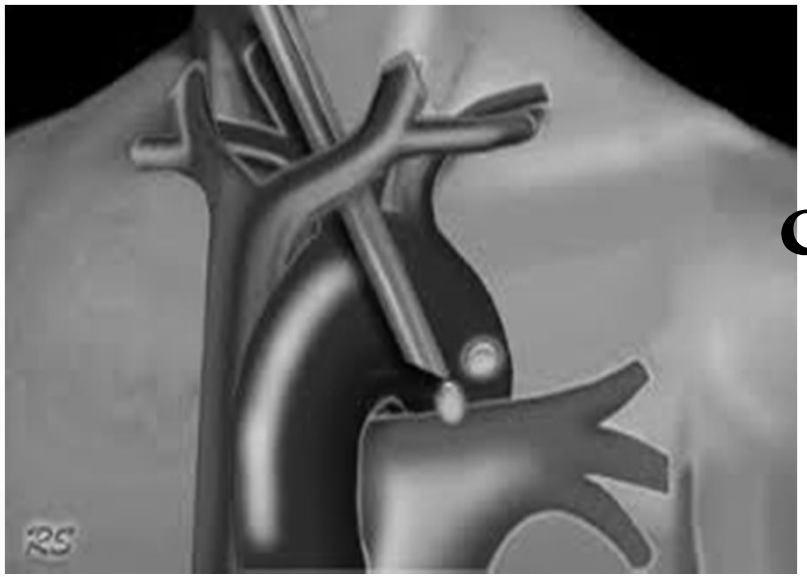


Evaluation of the mediastinun

- Imaging techniques
- Angiography echo, isotope flow scan: cardiac vascular anomalies
- I131 scan : substernal thyroid
- Bronchoscopy
- Mediastinoscopy (cervical, anterior)

Mediastinoscopy





cervical

anterior

drmarwareda@hotmail.com

Best wishes